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The Impact of Japanese Lesson Study on Preservice Teacher Belief Structures about Teaching and Learning Science

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The Impact of Japanese Lesson Study on Preservice Teacher Belief Structures about Teaching and Learning Science

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THE ROAD NOT TAKEN
Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;
Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,
And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.
I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I-
I took the one less traveled by,
And that has made all the difference. –Robert Frost

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The Impact of Japanese Lesson Study on Preservice Teacher Belief Structures about Teaching and Learning Science

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This study investigates how preservice teachers make sense of student-centered instruction with existing traditional beliefs about teaching. Teacher educators assume that university instruction translates directly into practice, yet, research is clear that beginning teachers revert to traditional teaching practice. For elementary teachers, one science methods course is assumed to be sufficient instruction in contemporary methods to successfully guide practice in their beginning years. Two main research questions are addressed: 1) Do preservice teacher belief structures change during the implementation of a Japanese Lesson Study cycle? 2) To what extent are preservice teachers teaching behaviors consistent with their belief structures?

To answer these questions, a case study methodology consisting of three preservice teachers, selected from a collective case study of 25 preservice teachers, was performed. The time periods of data collection were set with Lesson Study episodes. The time periods included pre-lesson study, during lesson study episodes, and post lesson study, with a conceptual framework synthesized from beliefs literature, Rokeach (1968),

Fishbein and Ajzen (1975), and operationalized within the context of a Science Methods course using Richardson et al (1991) and Pajares (1992) as a guide.

Findings indicate that even if preservice teachers have similar experiences with elementary science instruction, and have developed a traditional frame of reference (Kennedy, 1999) that guides their learning about teaching, each understands information idiosyncratically. When viewed in terms of Green's (1971) metaphor of belief structures, preservice teachers have widely differing frames of reference; thus, an individual's sense-making about inquiry lessons within lesson study groups and the meaning conveyed within conversations are completely different. Ultimately, the participants in this study can be described, metaphorically, as having a Crisis of Belief (Green, 1971), an approach of Quiet Introspection, and a Crisis of Practice.

For teacher educators, understanding preservice teacher understanding, and using that understanding in constructing lessons that facilitate evaluation of existing beliefs requires different lenses. The three lenses used are, Epistemological (Hewson & Hewson, 1984; Posner, Strike, Hewson, & Gertzog, 1982), Social/Affect (Pintrich, Marx, & Boyle, 1993; Tyson, Venville, Harrison, & Treagust, 1997), and an Expectational lens (Chi, Slotta, & de Leeuw, 1994). The selection of lenses is dependent upon the idiosyncratic nature of each preservice teacher's belief structure.

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Chapter 1: Introduction

The problem that this research seeks to address is, given one science methods course with preservice teachers holding traditional beliefs about teaching, teacher educators do not know how to bring about change in preservice teacher beliefs in a way that newly formed beliefs are resistant to pressures that "convince" preservice teachers to revert to their traditional ways of teaching, and traditional beliefs during their beginning years of teaching. In other words, teacher educators do not know how to effect change in closely held, "deep/primary" beliefs that are central to a teacher's belief system in a way that helps to negotiate current educational environments-in fifteen weeks. Elementary preservice teachers do enter into teacher education programs with images of teaching, and some form of beliefs about teaching science and student learning in science; however, over a one-semester science methods course, belief change (reorganization of a belief system's structure) is extremely difficult at best. Within fifteen weeks, teacher educators must find a way to have preservice teachers identify their images of teaching, and begin to realize and formulate their beliefs about teaching elementary science, and beliefs about student learning in elementary science. Once this process has begun, reasonable inferences about preservice teacher beliefs require "assessments of what individuals say, intend, and do" (Pajares, 1992, p. 327). These assessments must include "teachers' verbal expressions, predispositions to action, and teaching behaviors" (Pajares, 1992, p. 327). Indeed, as new ground is forged, methods of assessment and action on the part of both teacher educators and preservice teachers must be combined in new ways, and theory must be explicitly operationalized within the context of a teacher education program.

Since preservice teachers do not enter into teacher education programs as blank slates, they bring with them extensive, passive, K-14 experiences in classrooms in which they, themselves, were students. This experience has set the foundation for the constructs of their beliefs about teaching, and beliefs about student learning in schools. Indeed, their experiences in science classrooms or with science lessons have extended their existing constructs with new belief formation (about science) and reinforcement of existing beliefs about teaching and student learning in science classrooms. New instruction must create opportunity for preservice teachers to identify the existing images and beliefs that they hold about teaching, and strive to reconcile or re-think them with respect to new information, and new teaching experiences in the context of their preparation coursework.

One promising method of instruction that creates opportunity for reflection and challenge is Japanese Lesson Study (C. C. Lewis, 2002). Japanese Lesson Study was chosen to address the above points by providing a protocol for individual reflection on authentic classroom experiences, and social negotiation of knowledge that provides a rich opportunity for identification *of* prior images and beliefs about teaching, reflection *on* the images and beliefs, and opportunities *for* change. Preservice teachers take an active role in setting goals, gathering data through observation of their peers and self (via direct observation and videotape), and by engaging in a deeply reflective process centered around teaching and their personal understanding of teaching and learning from multiple perspectives. A reflective framework such as this is rare in teacher education programs (Darling-Hammond & Ball, 1998; C. Lewis, Perry, & Murata, 2006). The use of Lesson Study provides the grounds for identification *of*, and reflection *on* preservice teacher beliefs about teaching and learning, by preservice teachers themselves. Therefore, this research is centered on a course that is exemplified by the following quote:

> If a program is to promote growth among novices, it must require them to make their preexisting personal beliefs explicit; it must challenge the adequacy of those beliefs; and it must give novices extended opportunities to examine, elaborate, and integrate new information into their existing belief systems" (Kagan, 1992)

In order to address the deficiency of research in the literature regarding mechanism for belief change (how preservice teachers make sense of prior beliefs and images of teaching with respect to new information and experiences), as well as address the (empirical) research base of lesson study, I will contribute to developing knowledge about the "explication of lesson study's mechanism" (C. Lewis et al., 2006, p. 3), and contribute to a growing, but still limited, understanding of lesson study in the U.S. I will make the contribution by examining and understanding beliefs, the innate structure inherent in the belief system held by preservice teachers with respect to their prior experiences, and also contribute knowledge about how preservice teachers make sense of new instruction with respect to their existing beliefs (including images of teaching, and teachers), with an eye to a possible mechanism for change. The significance of this educational research is the contribution to an understanding of belief change in teacher education at a crucial juncture in time—teacher education is under increasing pressure to provide classrooms with highly qualified teachers. Additionally, this study contributes to a knowledge base that is significant to teacher education in a twofold manner. First, by contributing insights into belief change via change in structure of currently held beliefs, as well as offering Lesson Study as a methodology/pathway to facilitate preservice teachers to identify and reflect upon their existing beliefs in light of practice in authentic contexts, and new information learned in their coursework.

This work is particularly timely because teacher education is currently facing accountability pressures as a result of the No Child Left Behind Act (2002). The issue, every classroom must have a qualified teacher. The definition of "qualified" changes

depending on the level of instruction; however, according to the American Association for the Advancement of Science, "qualified" is defined as teaching in a student-centered manner. That teacher beliefs guide their classroom instruction and practice has been established through empirical research, and findings regarding belief formation are generally accepted (L. A. Bryan, 2003; Pajares, 1992; Richardson, 1990) it is important that belief elucidation be included in teacher educator's planning for instruction. Given the extent and variety of current and past research agendas on teacher beliefs (i.e. self efficacy, affect, or concerns), a significant finding (to educational research) pertaining to long lasting, deep seated change (on a large scale) in teacher beliefs and classroom practice is overdue, in part because of the very nature of the extent and variety of research agendas. In addition to the lack of significant research findings pertaining to large-scale change, no resultant deep, large-scale change in teacher beliefs and practice has been documented, nor existing change attributed to any one method or mechanism of instruction. By mechanism of change, I mean, mechanisms of belief change, or pathways by which teacher beliefs change. Further, how teachers make sense of new information and negotiate new beliefs (in light of existing beliefs) with respect to contemporary instruction has yet to be resolved.

Empirical studies have shown that teacher beliefs are resistant to change (Abelson, 1979; Nespor, 1987; Milton Rokeach, 1968), stable (Kagan, 1992, p. 66), formed through direct experience (M. Fishbein & I. Ajzen, 1975; Richardson, 1990; Milton Rokeach, 1968), and difficult to infer (Pajares, 1992). Further, the beliefs teachers hold guide their practice (Kagan, 1992, p. 66). In other words, teachers' classroom practice, regardless of the subject, is consistent with their framework for teaching, and the beliefs about teaching that they hold. Because of this, in order to prepare future teachers for teaching in contemporary environments, it is important to understand how preservice

teacher beliefs change in light of their existing beliefs and images of teaching. This is a major first step in resolving a mechanism (or mechanisms) for belief change, and preparing teachers for teaching in a contemporary manner.

Prior to the 1990's, no empirical evidence of the pathways and mechanisms that cause change in teacher beliefs has come to light (by way of empirical research) in the last few decades (Kagan, 1992, p. 65). Indeed, much is still not understood about belief change. Research that has been performed in the preservice, induction and in-service areas has been designed to impact student learning in science by way of targeting teacher classroom behaviors with respect to their beliefs. See, for instance, Abell and Bryan (1997). Even though research has targeted teacher beliefs and practice, a long-term change in teacher practice, where classroom teachers teach in a contemporary (student-centered) manner, has not been effected on a large scale. The pathways that pre-service, induction, and in-service programs take vary widely, each with differing results.

Research by Luft and Roehrig and Luft (2001; 2006) indicates that induction teacher education programs do make a difference in changing beliefs and changing classroom practice; however, this change is different for induction and experienced teachers. For example, with a pool of 14 induction and experienced teachers, Luft found that the data from her six induction teachers indicated that they were more likely to alter their beliefs than their practice (2001, p. 530). Most likely this is due to their inexperience in the classroom, and severe lack of experiences in teaching science in a reform-based manner. Therefore, most of the induction teachers were likely to have concerns with implementation, thus driving the instruction received in their program. Luft's data pertaining to the eight experienced teachers were different because the teachers already had multiple years of experience with teaching science, and already had an established belief system that supported teaching science as inquiry in a reform-based manner.

Therefore Luft concludes that two things are important guides within her study, and are consistent with literature. First, beliefs are formed and reinforced through experience. Since induction teachers had less classroom experience than experienced teachers, this seemed to take precedence in what the induction teachers focused upon, with their beliefs "subject to revision" (p. 532). Second, beliefs guide teacher practice. Since experienced teachers already held beliefs and skills conducive to the implementation of inquiry lessons in the classroom, they were more likely to focus on learning about and implementing lessons consistent with reform-based practice.

Roehrig finds that the type of preparation program does affect the learning, among induction year teachers, that takes place during the in-service program. Roehrig's sample consisted of sixteen participants collectively representing four preservice preparation programs—each with varying amounts of student-teaching experience. Roehrig and Luft (2006) found that the initial certification program did significantly influence the in-service teachers in direct relation to the prior experiences, and the impact that those experiences had on the beliefs held by participants. Specifically, induction teachers with "extended student-teaching experiences" (2006, p. 980) tended to use time in their induction program to "plan together or critically discuss the lessons they taught the previous month" (p. 980). Those induction teachers who did not have an extended student-teaching experience tended to focus on topics that should have been learned during methods courses, or other courses provided by formal licensure programs. Together, Luft and Roehrig found that teacher education programs are critical in developing the beliefs and practices of future classroom teachers (J. Luft, 2001), as well as induction programs providing extended support for the newly developing beliefs and practices of beginning teachers. In addition to research in science education, research in mathematics teacher education also frames this discussion.

Past studies about mathematics teacher education suggest that teacher beliefs about mathematics and how to teach mathematics are significantly influenced by experiences with mathematics and schooling before entering mathematics teacher education programs (e.g. C. Brown & Borko, 1992; S. Brown, Cooney, & Jones, 1990; Cooney, Shealy, & Arvold, 1998). "Thus, because the opportunity for changing their beliefs is essential for teachers' development… it is important to understand not only what teachers believe but also how their beliefs are structured and held" (Cooney et al., 1998, p. 306). Indeed, since research has shown that a teacher's beliefs guide their understanding of classroom situations and student learning, it also guides their judgment as their judgment is based on their current understanding of the situation, and also guides the implementation of lessons (Kagan, 1992). As Pajares states: "…understanding the belief structures of teachers and teacher candidates is essential to improving their professional preparation and teaching practices" (Pajares, 1992, p. 307).

Science teacher education programs (Abell & Bryan, 1997) and inservice programs (J. Luft, 2001; Roehrig & Luft, 2006) have been developed; however, individually, neither the teacher education program nor the inservice program is likely to be successful. The teacher education program must have a focus on eliciting existing beliefs and images of teaching held by preservice teachers, as well as an extended student-teaching experience—through which support is provided to reinterpret and re-learn existing traditional beliefs and experiences in traditional classrooms in light of new information and practical experiences provided within robust teacher education programs. These experiences must also seamlessly continue into the induction years if a long-term shift is likely to occur. Indeed, robust teacher education and induction programs must require more than minimal reflection on existing beliefs and images in order to effect lasting change in teacher beliefs and classroom practice.

After decades of research on teacher beliefs, the question remains: How can a lasting change be effected in classroom practice and behavior of teachers in order to move science instruction to reflect contemporary pedagogy, and resist pressures of the beginning years of teaching? There are several pathways along which change is theorized to occur however, as Richardson (1996) summarizes, "life experiences" (p. 106) in some way guide or shape the formation of robust beliefs that persist through contemporary instruction. It is these beliefs that need to be "surfaced and acknowledged" if the "deep structure of knowledge and beliefs" (p. 106) is to be influenced or changed throughout a teacher education program. Deep structure will be described later as the quasi-logical ordering (structuring) of primary and derivative beliefs in an individual's belief structure. Indeed, existing methodologies need to be conceptualized differently, or possibly conceptualized with combinations of existing measures used for making more robust belief inferences, and subsequent instruction created to target existing teacher beliefs (Kagan, 1990; Pajares, 1992; Richardson, 1996). Kagan (1990), in her review, suggests that "[t]he use of multimethod [multiple method] approaches appears to be superior, not simply because they allow triangulation of data but because they are more likely to capture the complex, multifaceted aspects of teaching and learning" (p. 459). Multimethod approaches combine the deep, colorful nature of qualitative research techniques that *seek to explain* with descriptive or statistical methods and techniques from quantitative research techniques used to elicit trends, most often with large sample sizes. Today, this approach has been developed to include mixed methodological research designs (Creswell & Plano Clark, 2007; A. Onwuegbuzie & Teddlie, 2003). In the case of this study, a mixed methodological triangulation design for convergence was chosen to allow qualitative data to be merged with quantitative data (Creswell & Plano Clark, 2007).

Two issues remain to be resolved. First, teachers fail to teach in a contemporary (reform-based) manner despite instruction on contemporary teacher education programs. Second, research has not addressed how teachers think and make sense of new information with respect to their existing beliefs. Further, current research has not elicited a mechanism (or process) that facilitates change in beliefs, nor has research been performed to demonstrate long-term change.

In sum, the problem that this research seeks to address is that, given one science methods course, teacher educators do not know how to change preservice teacher's beliefs in a way that newly formed beliefs are resistant to pressures that "force" preservice teachers to revert to their traditional ways of teaching, and old beliefs. In other words, teacher educators do not know how to effect change in closely held, "deep" beliefs that are central to a teacher's belief system.

PURPOSE

The purpose of this study is to investigate existing beliefs and images of teaching held by preservice teachers, through the use of the Japanese Lesson Study protocol. In theory, by eliciting foundational beliefs held by preservice teachers and encouraging them to reconcile their existing beliefs with new instruction and new experiences with practice lessons, a longer lasting and more robust change in beliefs about teaching and learning will be effected (Abell & Bryan, 1997; Cooney, Shealy, & Arvold, 1998).

RESEARCH QUESTIONS

Given the above purpose of this dissertation, two research questions are addressed in this study. Question 1: *Do pre-service teacher belief structures change during the implementation of a Japanese Lesson Study cycle? If so, how and to what degree do they change?* Question 2: *To what extent are preservice teachers teaching behaviors*

consistent with their belief structures? This distinction stems from the work of Abell and Bryan (1997), and is an "issue question" (Stake, 1995, p. 18), which places the primary importance on the issue, with each individual case being of secondary importance (Stake, 1995). However, since this is a subset of a larger study, each participant's case is of primary importance, thus this is an "intrinsic case study" (Stake, 1995, p. 3). In the context of the larger study, the collection of cases is important in addressing the issue of change in beliefs, and in the case of the larger study is formally called a collective case study (Stake, 1995, p. 4).

METHODOLOGY: CASE STUDY

The primary focus of this study is on the belief structure of each individual, and their beliefs about teaching and student learning in elementary science classrooms. Belief structures are idiosyncratic, and deeply personal; therefore, a case study methodology is appropriate. The three cases in this research have been selected as specific examples.

METHODS: MIXED

Due to the highly personalized nature of an individual's beliefs, and because of the difficulty of making inferences about an individual's beliefs, mixed methods design is appropriate. Therefore, this concurrent mixed methods study for triangulation is to better understand the formation and/or alteration of pre-service teacher beliefs by converging (triangulating) both descriptive, numeric trends from quantitative surveys with the detail of qualitative interviews. In this study, quantitative Likert scale instruments such as the Constructivist Learning Environment Survey (CLES) (Johnson & McClure, 2004), and Statements of Concern survey (SoCQ) (George, Hall, & Stiegelbauer, 2006a) were used to descriptively measure the relationship between an elementary science methods course in which Japanese Lesson Study is enacted, and pre-service teacher beliefs, concerns and

understanding of a constructivist learning environment. The multiple methods will also help establish trustworthiness and face value of findings. At the same time, the quality, complexity, and depth of pre-service teacher beliefs, concerns, and understanding of a constructivist-learning environment will be explored using both formal and informal, semi-structured, qualitative interviews (Teacher Beliefs Interview (TBI)) (J. Luft, Fletcher, & Fortney, 2005; J. Luft & Roehrig, 2005), questionnaires, observations, reflections, prescriptive prompts, and classroom artifacts with preservice teachers in a field-based, bilingual education program at The University of Texas at Austin. The researcher was the instructor of the course. The course was structured around a reflection orientation, thus reflection quality was emphasized. Preservice teachers electing to participate or not participate completed the same requirements.

CONCEPTUAL FRAMEWORK FOR BELIEF INFERENCES

The framework that supports this research is a social constructivist framework (Crotty, 1998), which is situated within an interpretivist paradigm. The elementary science methods course that this research is situated within has been conceptualized to follow a reflection orientation to teaching (Abell & Bryan, 1997), which is consistent with the philosophical stance of the course and researcher. An 'orientation to teaching' refers to the beliefs and knowledge about teaching (held by an individual), and can be used as a conceptual map to help guide instructional decisions (Magnusson, Krajcik, & Borko, 1999). The reflection orientation which guides the course utilizes Lesson Study, and is characterized by asking preservice teachers to describe their ideas, beliefs, and values about teaching science and student learning while providing experiences that allow them to identify, discuss, explore, and challenge their beliefs about teaching and learning in light of collected evidence. This orientation is underpinned by the belief that learning to teach science is a process of identifying, evaluating, re-evaluating, and

reforming existing theories about teaching and learning in light of new evidence collected (Abell & Bryan, 1997), all consistent with the social constructivist framework, and the interpretivist paradigm.

Several frameworks have been favored in the literature, for use in making belief inferences. Since beliefs are deeply personal and formed through direct experience, no one method of eliciting data used in making belief inferences has been presented. Regardless, any method selected for eliciting, collecting, and interpreting data for the express use in making inferences about beliefs must be guided by a framework. Several reviews have been published (See for example, Pajares, 1992; Philipp, 2007; Thompson, 1992) that mention the inconsistency of definitions underlying research, as well as the varied perspectives and research agendas that underpin research.

Two exploratory studies were conducted to reconcile two prevalent definitions of belief, and to develop a conceptual framework based upon the frameworks provided by Rokeach (1968), and Fisbein and Ajzen (1975). Much current research may be traced back to either of the above definitions. Therefore, the framework in this study was developed to effect a conversation, which may begin to reconcile the two research camps through the use of multiple perspectives. Specifically, both hold the common view that beliefs stem from, or are derived from personal experiences. Milton Rokeach (1968) discusses three kinds of belief, descriptive, evaluative, and prescriptive. He holds that multiple beliefs are clustered together and form attitudes, such as the sub-construct of self-efficacy, and that each cluster has a structure that varies along several dimensions, namely the central-peripheral dimension. Fishbein also discusses types of belief, however, it is his definition of attitude that differs from that of Rokeach. For Fishbein and Ajzen (1975), like Rokeach, an attitude is a collection of beliefs, however, a belief is the link between a object and its attribute. Rokeach holds that a belief can be a simple

statement inferred from what a person says and does. Differences such as these make understanding and synthesizing current and past research very difficult, especially given the lack of discussion in the literature about differing definitions of belief. Therefore, a conceptual framework (Table 1.1) is offered to help make sense of the various perspectives, definitions, findings, and interpretations provided by literature and theory.

This framework juxtaposes Rokeach's definitions (kinds) of belief with Fishbein's theoretical framework on beliefs, and opens the door for interpretation and discussion of research from multiple perspectives grounded within different definitions of belief.

Table 1.1: Conceptual framework for belief inferences (selection of methods)

	Cognitive[1] Component of Belief (Statement of opinion, belief or thought.)	**Affective[1] Component of Belief** Statement of feeling/affect or value (with respect to a belief or opinion.) that assumes a positive or negative stance with respect to the belief or opinion.	**Behavioral[1] Component of Belief (Intended)**	**Behavioral Component of Belief (Actual)**
Descriptive[2] Belief Descriptive statements of belief, opinion, feeling, value, concern, or behavior/action that is non-evaluative or prescriptive.	Descriptive statement of opinion, belief, or thought that may be labeled as True, or False. Ex: A teacher begins lesson planning by looking at the curriculum. Ex: A teacher is a mentor.	Descriptive (positive or negative) statement of feeling/affect or value that indicates a like or dislike, feeling, or concern. Ex: I admire teachers. (Statement of admiration exposes underlying value for teachers.) Ex: I am concerned about teaching students the wrong terminology.	Any descriptive statement or response indicating behavioral intent when presented by a given situation. (M. Fishbein & I. Ajzen, 1975)	Description of, reflection on, or response to, the actual behavior or response when the situation arose.
Evaluative[2] Belief Beliefs that expose an underlying belief, opinion, feeling, value, concern, or behavior/action by evaluating, comparing, or judging.	Evaluative statements about beliefs or opinions regarding what is good or bad. Ex: Teaching is good for society.	Statement of affect or value that evaluates, compares, or judges. This is the Evaluative, comparative, or judgmental function of a belief that takes a positive/negative stance or evaluates as good/bad.	Evaluative, comparative, or judgmental statement or responses indicating behavioral intent. Statement or response will evaluate what s/he intends to do in a given situation. (Good/Bad or Positive/Negative)	Evaluative, comparative, or judgmental statement or response of what s/he did do when confronted with a given situation.
Prescriptive[2] Belief Any statement about the desirable or un-desirable nature of a future belief, opinion, feeling, value, concern, or behavior/action.	Any statement or response that advocates a future opinion or belief that is desirable or undesirable or advocates a future opinion or belief as good or bad. Ex: When I teach this lesson, I will use a hands-on approach.	Any statement or response that advocates a future position/affect or value that pertain to feelings or evaluations elicited by questions in print or oral form.	Any statement or response that advocates action about what s/he intends to do when confronted with a future sitation. Ex: I will ask the student questions like "what, "where," "why," or say "show me" or ask for an example.	Response or Statement that advocates a future belief, opinion, feeling, value, concern, or behavior/action. Ex: Next time, when I approach a student group, it will be better if I ask the question " What have you done so far?" I will follow that up with " Show me."

[1] (M. Fishbein & I. Ajzen, 1975)

[2] (Milton Rokeach, 1968)

The conceptual framework of this study is designed with Milton Rokeach's definition of belief as the *pathway* for data collection, as called for by exploratory studies with preservice teachers which indicated the imperative to operationalize belief statements in the context of this research. The theoretical framework of Fishbein and Ajzen, then, provides the boundaries for data collection, and subsequent data for belief inferences—based on a trajectory of prediction of social behavior, and behavioral change. In short, this conceptual framework has been developed to provide a rich source of data, and triangulate beliefs inferences from multiple perspectives, as well as evaluate data in light of differing definitions.

Regarding the use of multiple definitions, Rokeach distinguishes attitudes as a collection of beliefs (with some degree of connectedness), and defines a belief as a "simple proposition" (Milton Rokeach, 1968, p. 113) based on inferences made from various data sources. Attitudes, then, are composed primarily of evaluative beliefs, or statements of affect. Fishbein and Ajzen's definition is explored below.

The conceptual framework, in turn, guided the selection of tools for data collection. The conceptual framework provides for several sources of data that require participants to describe, evaluate, and prescribe (Rokeach), their perceptions (beliefs and opinions), attitudes, and behaviors (intended and actual) from which, belief inferences were made. The sources of data are selected from the criteria Rokeach discusses, and are conceptualized to elicit data that highlights an internal/external divide in participant beliefs. The conceptual framework highlights an internal (private) side, in that an individual's beliefs are private, and not visible to another person. (Indeed, the personal beliefs may never be made public.) Data collected that provides insight into the internal/private beliefs are designed to triangulate participant self-report data and support the use of multiple lenses to triangulate beliefs by giving the researcher insight into the

unfiltered/private belief system. When made visible through self-reporting (the public side of an individual's beliefs), expressed beliefs must still be triangulated, due to the "self-report" nature of data, and contrasted with actual behaviors exhibited during teaching activities. The triangulation is necessary, because as pre-service teachers begin to verbalize their beliefs, they may modify their private/hidden beliefs according to real or perceived pressures. This is a limitation of self-report data. The boundaries that Rokeach ascribes to an individual's internal/hidden beliefs are that they may be "conscious" or "unconscious," and must be inferred from what a person says (internal/private beliefs made visible through some form of representation) and does (external/visible representation or exhibition of behavior) (Milton Rokeach, 1968, p. 113).

The rows listed in the framework (Table 1.1), are inspired by Milton Rokeach in that he contends that there are three main types of belief. They are "descriptive," "evaluative," and "prescriptive" (p. 113). Each belief is comprised of three components, as will be discussed below. Cognitive component, affective component, and conative (intention) components all are theorized to comprise a belief, with the overt action an observed manifestation of a combination of the three components.

Generally, an individual's descriptive beliefs can be classified into in the form of statements of opinion, feeling, value, concern or behavior/actions that are non-evaluative, and non-prescriptive in nature. *A teacher is a mentor*, is an example of a descriptive statement, as it assumes a true or false stance, and does not evaluate or prescribe a future action. Evaluative beliefs are beliefs that give insight into an underlying belief, opinion, value, concern, or behavior/action through statements that evaluate, compare, or judge. *Teaching is good for society* is an example of an evaluative statement in that it places a good/bad, evaluation on the profession of teaching. Prescriptive statements of belief, by

definition, are statements about the desirableness or un-desirableness of a future belief, opinion, feeling, value, concern, or behavior/action. For example, *When I teach this lesson, I will use a hands-on approach*, is an example of a prescriptive statement. Since the purpose of this conceptual framework is to provide data sources that triangulate a participant's foundational beliefs about teaching and learning in a science classroom, attitude components are important, as well as intentions and overt actions. Therefore, cognitive, affective, and conative components have been included into the conceptual framework. They are all found in Rokeach's definition, with combinations of statements providing insight into a participant's attitudes, and therefore, when combined with an individual's actions and statements, provide insight into their underlying (private/hidden) beliefs. It is important to note that current research demands a clear definition of belief that is consistent with methods used, as well as consistent with a clear conceptualization of the construct under study. This will be further developed in the next chapter.

Since beliefs may be predispositions to action, they are generally conceptualized to be the foundation with which attitudes are built. "An attitude is thus a set of interrelated predispositions to action organized around an object or situation" (Milton Rokeach, 1968, p. 113). According to Rokeach,

> "[e]ach belief within an attitude organization is conceived to have three components: a cognitive component…an affective component…and a behavioral component" (1968, pp. 113-114). Rokeach continues: [A] *cognitive* component…represents a person's knowledge, held with varying degrees of certitude, about what is true or false, good or bad, desirable or undesirable; an *affective* component, because under suitable conditions the belief is capable of arousing affect of varying intensity centering around the object of the belief, around other objects (individuals or groups) taking a positive or negative position with respect to the object of belief, or around the belief itself…and a *behavioral* component, because the belief, being a response predisposition of varying threshold, must lead to some action when it is suitably activated" (original emphasis, pp. 113-114).

The behavioral component has been further divided into intended behavior and actual behavior, providing insights into the private/public divide. In order to facilitate reflection by preservice teacher participants on their intended actions, reasons for their intended actions, and the actual behaviors they exhibited during their teaching episode during Lesson Study, video was used as a tool for reflection. This also provides additional opportunities to expose underlying beliefs.

The conceptual framework depicted in Table 1.1 also includes Fishbein and Ajzen's theoretical framework. Fishbein and Ajzen's theoretical framework holds that the beliefs a person holds influences his or her attitude toward a belief object (anything, anyone, any idea, or any situation), which in turn influences his or her behavioral intentions with respect to the belief object (M. Fishbein & I. Ajzen, 1975, p. 15). Further, the intentions with respect to a certain belief (termed "belief object" (p. 15)) influence the person's actual behavior with respect to her or his original beliefs. In short, Fishbein and Ajzen's theoretical framework holds that an individual's beliefs or opinions (cognitive component of a belief) influence their feelings and evaluations (attitudes), which in turn guide their behavioral intentions (conation). Last, an individual's actual behavior (observed overt action), performed in light of a certain situation is guided by their behavioral intentions, as well as other influences. Martin Fishbein and Icek Ajzen's definition of belief, on the one hand, specifies a belief as the *connection between* or *link between* an object and its attribute. Specifically, they describe a belief as "…the subjective probability of a relation between the object of the belief and some other object, value, concept, or attribute" (M. Fishbein & I. Ajzen, 1975, p. 131). In this research, the connection may very well be between the teacher (the object of the belief) and the attribute (teacher as provider of information). Explicitly stated, *the teacher is the provider of information* portrays information that may be used to infer the foundational belief

about the role of the teacher held by the preservice teacher who provided this answer. This relation is as Pajares says, a "belief about construct" (Pajares, 1992, p. 316). In the above example, the belief about the teacher will also be held with additional beliefs about teaching and student learning in science classrooms.

From Rokeach's perspective, Fishbein and Ajzen's definition of belief falls into the category of an attitude in that it is a collection of beliefs that are simple statements. Irrespective of the definition for belief, the framework in this paper provides for selection of methods that allow differing definitions to be applied to data. This framework opens up discussion within and across varying research agendas by way of allowing focus to be trained on the respective definitions that underpin the specific research agenda. However, regardless of the agenda or the definition that underpins the research, belief inferences may be made as to the specific foundational beliefs that are held by an individual pre-service teacher, and used to understand how preservice teachers make sense of new information with respect to their existing experiences, belief structures, and knowledge about teaching and learning in elementary classrooms.

DEFINITION OF KEY TERMS

Current beliefs research holds that definitions be made explicit, therefore a few definitions are appropriate. Belief, as defined in this research, is the definition proposed by Milton Rokeach in 1968. Rokeach (1968) defined belief as: "any simple proposition, conscious or unconscious, inferred from what a person says and does, capable of being preceded by the phrase "I believe that…"" (1968, p. 113). Rokeach discusses several types of belief, as well as attitudes being comprised of a collection of beliefs-each belief having three components. The types of belief, and their components, were discussed above. In short, Rokeach distinguishes beliefs from attitudes, and defines a belief as a "simple proposition" (p. 113). His definition recognizes that beliefs may be distinguished

on the basis of their public and private nature. He states: "A belief is any simple proposition, conscious or unconscious, inferred from what a person says or does…" (p. 113), thus lending insight into a possible avenue to reconceptualize a conceptual framework for research on beliefs.

Reflection Orientation

The reflection orientation is characterized by asking preservice teachers to describe their ideas, beliefs, and values about teaching science and student learning while providing experiences that allow them to identify, discuss, explore, and challenge their beliefs about teaching and learning in light of collected evidence. This orientation is underpinned by the belief that learning to teach science is a process of identifying, evaluating, re-evaluating, and reforming existing theories about teaching and learning in light of new evidence collected (Abell & Bryan, 1997).

Knowledge

Knowledge is defined as either tacit (intuitive knowledge), or propositional knowledge, "knowledge expressed in language form" (Lincoln & Guba, 1985, p. 40), and to be distinguished from components within a belief system, must have a socially accepted component generally recognized as "truth" (Abelson, 1979).

Knowledge System

Knowledge systems are distinguished from beliefs systems with the characteristics noted in the next section. For some researchers, knowledge systems are not distinguished from belief systems. This research does not seek to separate knowledge and beliefs systems. See Abelson (1979) and Nespor (1987) for examples.

Beliefs System

A metaphor for describing the manner in which one's beliefs are organized in a cluster, generally around a particular idea or object, is defined as a beliefs system. Beliefs systems are associated with three aspects: (a) beliefs within a system may be primary or derivative; (b) beliefs within a system may be centrally or peripherally located; (c) beliefs are never held in isolation and might be thought of as existing in clusters (Rokeach, 1960; Milton Rokeach, 1968).

> A belief system may also be defined as having represented within it, in some organized psychological but not necessarily logical form, each and every one of a person's countless beliefs about physical and social reality; indeed, by definition, [beliefs are not allowed] to exist outside the belief system for the same reason that the astronomer does not allow stars to remain outside the universe (Milton Rokeach, 1968, p. 2)

In this research, *belief system* simply refers to the implicit or explicit connections or similarities between beliefs that may be consistent with or inconsistent with the image of teaching professed by the preservice teacher. For example, a belief statement "I believe that the teacher is the source of information in the classroom. When the teacher leaves, all learning stops" would be consistent with an additional statement such as "Having students work in groups is a waste of time. They can't learn from each other." However, the statement "Group work is a great way to get students to help each other, since they each have a different understanding of what I am teaching" is an example of a supporting statement that is inconsistent with the initial belief statement.

A beliefs system, according to Abelson (1979), is a "stored body of structured knowledge" (p. 356), in that concepts and propositions are interrelated to some degree (p. 356). Abelson conceptualizes seven key elements that, if present within the system, indicate that it is a beliefs system. They are as follow: First, non-consensuality, which entails that an element contained in one person's belief system may be very different

from an element in another person's belief system, within the same content domain (p. 356). A key note is that if the person holding the non-consensual element is aware that others' may disagree with her/his element, it is disputable; therefore it is part of a belief system, and not part of a knowledge system. Second, "belief systems are in part concerned with the existence or nonexistence of certain conceptual entities" (p. 357) such as God, or ESP (p. 357). "To insist that some entity exists implies an awareness of others who believe that it does not exist. Moreover, these entities are usually central organizing categories in the belief system, and as such, they may play an unusual role which is not typically to be found in the concepts of straight knowledge systems" (p. 357).

Third, "belief systems often include representations of "alternative worlds" (p. 357), such as in the case of teacher education, different teaching philosophies.

Fourth, "belief systems rely heavily on evaluative and affective components" (p. 358). This is further delineated by Abelson into cognitive and motivational (affective) aspects. Simply put, evaluative components define elements as good or bad, or as "leading to good or bad" (p. 358), and may be highly connected to, or influence, other elements in an individual's belief system. When activated, these evaluative elements may have a strong motivational force.

Fifth, belief systems are likely to contain a major amount of episodic memories from previous experiences, where knowledge systems are primarily composed of generally accepted facts and principles (p. 359).

Sixth, the content contained within a belief system is 'usually highly "open'" (p. 358), with many connections to content from other domains, and personal experiences that seem to be outside a specific belief system. In the case of classroom teachers, the social environment may contain or incorporate elements based upon experiences outside of science education, and classrooms in general. For example, if the preservice teacher

believes that the classroom teacher is the sole provider of information (a prior experience from within the classroom), and that discipline and conduct in the classroom is based on a strong sense of respect (a prior experience based upon familial experiences), then these apparently non-related beliefs may combine to squelch any argumentation, scientific or otherwise, in the science classroom.

Last, the seventh element, beliefs may be held with "varying degrees of certitude" (p. 360) in that an individual may be passionate about a specific characteristic that a teacher should hold (the classroom teacher facilitates student discussion and exploration by asking open-ended questions, and not giving answers), whereas knowledge systems are composed of generally accepted facts that are not held more strongly than others.

Beliefs Structure (Beliefs System Structure)

Thompson (1992) discusses belief systems as being "appropriate, at least from a structural point of view, to conceive of a belief system much in the same way that we think of a cognitive structure in a particular conceptual domain. As such, belief systems are dynamic in nature, undergoing change and restructuring as individuals evaluate their beliefs against their experiences" (p. 130). Evidence of these changes is gained by using concept map techniques as a research tool, with informational maps constructed from interview data by the researcher. This will be described in chapter 4. Structure is constituted by the links in a concept map, or the links a participant makes in interview statements, as well as relationships related or alluded to by participants. In this research: Beliefs are based on/formed from knowledge, which is constructed from direct experiences, or derived from authoritative sources. For this research, *structure*, denotes the inferred connections with, within, or between beliefs within the beliefs system, or sub-construct within the system. For example, a participant's beliefs about teaching and student learning in science classrooms are considered to be sub-constructs within the

participant's belief system about teaching in general. A sub-construct is constructed from a collection of statements, observations, reflections, and other data that contribute to an understanding and making of subsequent belief inferences regarding the sub-construct. In this research, there are two sub-constructs of teaching being studied. They are beliefs about teaching, and beliefs about student learning in science.

The beliefs system structure, or belief structure, is conceptualized as fluid, dynamic, and possibly hierarchical, with an idiosyncratic organization. Specifically, "belief system" is defined as the combination or grouping of beliefs around a similar concept, which may be a subset of an individual's global belief system. Further, an individual's global belief system contains all beliefs held by an individual, with no beliefs existing outside the global belief system. The way that the beliefs in a belief system are connected, isolated, *consistent with* or *inconsistent with* the individual's epistemology and foundational beliefs about teaching and learning in science is termed the ***structure*** of the belief system.

Innovation

Innovation is defined as: learning to teach elementary science in a constructivist, student-centered, manner. Further, innovation means teaching an inquiry science lesson.

ORGANIZATION OF DISSERTATION

The organization of this dissertation: Chapter II: Review of Literature, reviews the relevant literature for this study (that presents a clear and consistent definition of belief-consistent with Milton Rokeach's definition that has been previously stated), and the pertinent literature used in the creation of the conceptual framework. Chapter III: Methodology, describes the equal status, mixed method triangulation design for convergence of data on belief inferences with data gathered on a baseline/pre/post design,

as well as the tools employed for data collection. Chapter IV: Results, presents the three participant cases, individually beginning with the background and initial beliefs and images of teaching of each of the participants. Each initial point is then followed with participant midpoint beliefs, then end of semester beliefs. Finally, discussion of the findings from the individual participants, as viewed with a lens presented by Hall and Stiegelbauer in their writing about the Concerns Based Adoption Model (CBAM). This is the theoretical framework that guides the interpretation of this work—a framework for individual change. It is in this section that both research questions will be addressed. A cross-case analysis is then presented, and represents the big picture of each participant with respect to the other participants, and the cross case analysis and big picture of individuals within their Lesson Study groups. Chapter V: Discussion and Implications is the last chapter, which also provides recommendations for teacher education programs, as well as discusses ethical issues related to creating belief profiles, and suggestions for future research.

Chapter 2: Literature Review

INTRODUCTION

> The kind of learning found in rich professional development settings…is *centered around the critical activities of teaching and learning*-planning lessons, evaluating student work, developing curriculum-rather than around abstractions and generalities; it grows from *investigations of practice* through cases, questions, analysis, and criticism; and it is built on *substantial professional discourse* that fosters analysis and communication about practices and values in ways that build collegiality and standards of practice (Ball & Cohen, as cited in Darling-Hammond, 1997, p. 323). These elements are the building blocks for a seamless process of professional learning that begins in preservice education, continues through the early years of induction, and extends through years of developing accomplished practice. (Darling-Hammond, 1997, p. 323, original emphasis)

Pre-service teacher education programs are critical in beginning the development process of beliefs and practices of future science and mathematics classroom teachers (Richardson, 1990; Thomas & Pedersen, 2003). It is generally accepted that teacher beliefs about science and how to teach science are significantly influenced by experiences with science and schooling before entering science teacher education programs. That these formal and informal experiences with teaching may be the foundation upon which teacher beliefs about teaching and student learning are formed is not surprising, since research suggests that beliefs are formed upon, and guided by personal experiences and knowledge. Research shows that preservice teacher practice may progress from teacher-centered instructional practice toward reform-based, constructivist practice throughout a teacher education program, yet, drastically shift back to traditional teacher-centered instruction during their first years of teaching (Fletcher, 2006 dissertation). This suggests that preservice teacher beliefs about student-centered instruction did not change in a

substantial manner that impacts the implementation of reform-based practice in the classroom.

The early identification of preservice teacher beliefs are crucial in the development process of learning to teach. “Because the opportunity for changing their beliefs is essential for teachers’ development…it is important to understand not only what teachers believe but also how their beliefs are structured and held” (Cooney, Shealy, & Arvold, 1998, p. 306). Pajares (1992) noted, “The beliefs teachers hold influence their perceptions and judgments,” and “understanding the belief structures of teachers and teacher candidates is essential to improving their professional preparation and teaching practices” (p. 307).

In this research, “belief system” is defined as the combination or grouping of beliefs around a similar concept, which may be a subset of an individual’s global belief system. Further, an individual’s global belief system contains all beliefs held by an individual, with no beliefs existing outside the global belief system. The way that the beliefs in a belief system are connected, isolated, *consistent with* or *inconsistent with* the individual’s epistemology (discussed below) is termed the ***structure*** of their belief system. This research seeks to understand the *structure* of a preservice teacher’s belief system about teaching and learning in science, and the impact that a highly reflective process (Japanese Lesson Study) has on the structure of preservice teacher belief system. It must be noted that an individual’s belief system about teaching and learning in science may also be termed a ‘sub-system’ of their global belief system; however, in this paper, “system” refers to the construct of beliefs about teaching science at the elementary level, and the construct of student learning in elementary science.

Thomas and Pedersen (2003) furthered the discussion about change in pre-service teacher beliefs, contending “Pre-service teachers may develop a new vision while

keeping traditional practice beliefs intact" (p. 328). In other words, pre-service teacher understanding of reform-based practice is superficial, and has not impacted their prior (traditional) beliefs about practice. As Thomas and Pedersen discuss, the problem is the degree to which teachers engage in dialogue concerning their personal practice and take control of their classroom activities, as well as engage in dialogue regarding their theoretical justifications of their practice (Richardson, 1990; Thomas & Pedersen, 2003). This engagement needs to be more than superficial to effect change. Specifically, without discussion, engagement in teaching lessons, reflection upon prior beliefs and images of teaching science, new interpretations or understandings about practice will not occur.

Frank Pajares, in his review of educational research, notes:

> [t]eacher's beliefs can and should become an important focus of educational inquiry but that this will require clear conceptualizations, careful examination of key assumptions, consistent understandings and adherence to precise meanings, and proper assessment and investigation of specific belief constructs (Pajares, 1992, p. 307).

Pajares (1992) synthesized findings from prominent researchers, and suggested directions that future research may take toward arriving at a consensus on terminology and definitions for research on the structure of belief systems. One exceptionally difficult suggestion is to re-evaluate the selection of methods and instruments in order to provide a more robust foundation for making belief inferences. Facilitating consensus entails a discerning selection of methods and instruments upon which to base belief inferences that are open to scrutiny from differing paradigms, epistemologies, and frameworks. The astute selection values multiple perspectives, values multiple forms of representation, and values a combination of methods by which individuals give evidence of (and insight into) their beliefs, their belief statements, their intentions to act or respond in a predisposed manner (prescriptive evidence), and reflection upon their actual behavior, action, or response in light of situated context(s) when confronted with the belief in question.

PROBLEM STATEMENT

The problem, as stated in Chapter 1, is that teacher educators do not know how to change preservice teacher's beliefs in a way that newly formed beliefs are resistant to pressures that "convince" preservice teachers to revert to their traditional ways of teaching, and old beliefs during their beginning years of teaching. In other words, teacher educators do not know how to effect change in closely held, "deep" beliefs that are central to a teacher's belief system, on a large scale.

The purpose of this study is to investigate existing beliefs and images of teaching held by preservice teachers, through the use of the Japanese Lesson Study protocol. In theory, by eliciting foundational beliefs held by preservice teachers and encouraging preservice to reconcile their existing beliefs with new instruction and practice lessons, a longer lasting and more robust change in beliefs about teaching and learning will be effected.

Historically, there have been three main research perspectives that can be applied to teacher change. They are as follow. The first perspective suggests that an individual's beliefs guide or influence their behavioral actions or decisions about how to act (M. Rokeach, 1968), thus, in order to change teacher practice in the classroom, individual teacher beliefs must be understood, and targeted for change. Rokeach suggests that beliefs are initially formed either through direct experiences or derived/assimilated from personally accepted authoritative sources. Since beliefs guide practice, targeting the beliefs of pre-service and in-service teachers should provide opportunity for change in the classroom practices or behaviors of teachers.

Fishbein and Ajzen's Theory of Reasoned Action (1980; 1975) "…beliefs influence attitudes, which in turn influence intentions…which in turn, influence

behavior" (D. Shaffler, 1990, p. 62) regards behavioral intention as being guided/framed by existing beliefs and as the precursor of behavior. This is based on the assumption that "human beings are usually quite rational and make systematic use of the information available to them" (I Ajzen & M Fishbein, 1980, p. 5). Further, the Theory of Planned Behavior (Ajzen, 1985) refines the Theory of Reasoned Action by applying two conditions: time (time has been shown to effect the intention-behavior relationship) and volitional control (the individual must be able to easily perform the behavior) (D. Shaffler, 1990).

Guskey (1986), whom we will discuss in the second perspective, further elaborates the process of targeting teacher beliefs for change in order to effect change in teacher behavior and classroom practice. He discusses this process as a pathway toward changing teacher practice in the classroom by first attempting to initiate (some form of) change in the "beliefs, attitudes, and perceptions of teachers" (1986, p. 6). See for example, Fullan (1982). Guskey continues discussing a change process mainly derived from early change theorists, such as Lewin's text (1935) A Dynamic Theory of Personality, with an example:

> [m]any staff developers try to change teachers' beliefs about certain aspects of teaching or the desirability of a particular curriculum or instructional innovation. They presume that such a change in teachers' beliefs and attitudes will lead to specific changes in their classroom behaviors and practices which, in turn, will result in improved student learning (Guskey, 1986, p. 6).

The second perspective on teacher change comes from the professional development literature. This perspective takes the opposite tack and suggests that in order to affect teacher beliefs, a teacher's classroom practices must first be altered (Guskey, 1986). The premise, here (recognizing that teacher beliefs are persistent, and resistant to change), is that in order to facilitate belief change, classroom teachers must first see a positive change in student outcomes as a result of their new teaching behaviors. (Guskey,

1986) In other words, teachers must change their classroom behaviors and deem the change valuable based upon observed student outcomes before change in beliefs about teaching may occur. This has traditionally been based upon the assumption that "…change is a learning process for teachers that is developmental and primarily experientially based" (Guskey, 1986, p. 7). Thus, beliefs are derived from experience.

The third perspective is a combination of the previous two, in that both avenues for change can occur at the same time, within different individual teachers, as change can be viewed as an idiosyncratic process. Within the same professional development program, or teacher education course, both may be pathways to belief change. See for example, Franke, Fennema, and Carpenter (1997). Specifically, given the opportunities within a professional development program, some teachers may change their classroom practices first, then (through this) begin to change their beliefs, while other participants may change their beliefs first, with classroom practice then aligning with their new beliefs. Change can be a chaotic and non-linear process (M. Fullan, 1993), especially since there is not a uniform set of beliefs and practices that are held by preservice teachers and beginning teachers. Too, individual beginning and in-service teachers have different backgrounds and beliefs that are related to prior experiences that must be taken into account (Fortney, Fletcher, & Luft, 2004, p. 6; J. Luft & Roehrig, 2004)

Of the three perspectives discussed above, the common thread to all three "…is the underlying notion that teacher change results in changes in both one's beliefs and practices" (Nathan & Knuth, 2003, p. 202), and not just change in either beliefs or practices.

There is a different perspective, which I will call the Alignment perspective. In this perspective, either classroom practice has shifted to be consistent with beliefs about teaching, or beliefs about teaching have shifted to be consistent with practice. The key is

that there is a mismatch, or tension (L. A. Bryan, 2003) that exists between the two. This can be summarized by Nathan and Knuth (2003), "[c]hanges in teachers' practices can occur within a consistent belief system when the new practices – which may be very different from the old ones – are compatible with their old (and still current) beliefs" (p. 202). Specifically, there may *not* be a change in teacher beliefs, yet, teacher practice may shift to better align with personal beliefs. This is consistent with the teacher change perspective discussed by Michael Fullan (1993), as well as findings from Bryan (2003).

Despite the above research, a mechanism or process (Kagan, 1992) for change is still not understood. Therefore, it is important to understand the thinking of the individual, and outline how each individual makes sense of new information and experiences in light of existing beliefs, and prior knowledge. This way of making sense of new information must be crucial to teacher educators.

IMPORTANCE TO SCIENCE TEACHER EDUCATION

One question to be considered by the field of Science Teacher Education: Why is preservice teacher education important? It is important in that the educational background learned in teacher education programs does have an impact within induction teacher education programs. For example, Luft and Roehrig found that the type of preservice program is important in induction programs (2006) as teachers educated in a traditional program show little evidence for learning from a contemporary induction program. Specific evidence indicates that teachers educated in traditional teacher education programs show no change in their classroom practice as they learn new methods of teaching. Likewise, teachers educated in contemporary programs show a better understanding of instruction and show new methods of teaching in their teaching practice. According to Simmons et al, there is often a mismatch between beliefs held by classroom teachers and the practices exhibited in their classrooms (Simmons et al., 1999).

In other words, teachers educated in contemporary teacher education programs show more evidence for learning (evidenced by alteration of classroom behaviors) as they progress through an induction program than those educated through a program that develops traditional teaching beliefs.

CONTEMPORARY TEACHER EDUCATION PROGRAMS-TIME FOR REFLECTION

A contemporary teacher education program may be defined as a program that teaches pedagogy which professes that the role of the teacher is student-structured (National Research Council, 1996), where student prior knowledge guides planning for instruction, and student learning guides the planning of lessons, as well as the scaffolding of concepts that take place. Scaffolding may be defined as the implementation of lessons (or progression of topics) that allow for material to be manageable for students. Teachers educated within a contemporary teacher education program have had time to elicit and reflect on their existing beliefs, and to continue developing a new belief system that will guide their classroom instruction and behavior during lessons. Luft, in her research, found that preparation for belief change begins in preservice teacher education programs (2001). Quite possibly, a contemporary framework for teaching, or new set of beliefs is seeded that, with practice and reflection, are more conducive to contemporary induction programs.

ONE METHOD FOR BELIEF REFLECTION: REFLECTION ORIENTATION

One method successfully used to create space for preservice teachers to reflect on their personal beliefs within a science methods course, specifically refers to a classroom orientation (Abell & Bryan, 1997). The orientation, as defined by Abell and Bryan (1997), is termed a "reflection orientation" (p. 154), or use of reflection as a pedagogy. The reflection orientation is grounded in the eliciting the "ideas, beliefs, and values" (p.

154) held by preservice teachers, and the crafting of activities and experiences that help preservice teachers "clarify, confront, and possibly change" their images and conceptions of teaching and student learning in a science classroom (p. 154). Preservice teachers identify their current beliefs, and are guided by their instructors to evaluate their currently held beliefs in light of new information, and new experiences. The identification of existing preservice teacher beliefs allows preservice teacher instructors to craft new experiences that set the stage for preservice teachers to experience situations that may contradict their current beliefs, and, through guidance and reflection, potentially change their existing beliefs. Therefore, new experiences are crafted to target existing beliefs and potentially bring beliefs in line with practice, or in the case of Barbara, as described below (Bryan & Abell, 1999), who brings practice in line with emerging beliefs.

Example of Barbara

Barbara was a traditional fourth-year student in that she did not take time off during her coursework. She was purposefully selected from her science methods colleagues in that she was particularly enthusiastic about elementary science, and open to sharing her beliefs and thoughts about science teaching and learning. During her second semester in the study, Barbara student taught at a local high school. At that time of her methods course, Barbara realized a tension existed in that her beliefs said one thing, while she observed something else. In her case, Barbara observed a teacher, Mrs. Clark, moving to a new topic before all students understood the topic that she (Mrs. Clark) had been currently teaching. Barbara, during the next semester that she student taught, realized that the tension that existed became more poignant, in that she was now the teacher that had to make that decision. Ultimately, upon reflection and numerous such lessons, Barbara began to address the "discrepancy between her espoused beliefs and her

enacted beliefs. She began to address the discrepancy by bringing her practice in the classroom to become more in line with her newly emerging beliefs.

The "fallacy of assumptions" that Bryan and Abell argue (1999, p. 136) are the assumptions that underpin traditional teacher education programs. Assumptions such as, information learned through coursework may be directly translated into practice, and that professional knowledge will develop before actual classroom experiences. They argue that, without classroom experiences, and reflection upon those experiences, future teachers may not be compelled to reconcile their beliefs with their practices. Further, newly emerging beliefs are threatened with extinction as tensions and pressures mount during the first few years of teaching. Because of this, the stage is set for preservice teacher education program reform (J. Luft et al., 2005).

Because of research like Bryan and Abell, we know that the impact of instruction on teacher beliefs is crucial (Pajares, 1992). Since it is commonly held that beliefs are formed from direct experiences (Nespor, 1987; Pajares, 1992), by the time preservice teachers get into teacher education programs, they have had over ten years of "passive experiences" (Fortney, 2007; B. Fortney & J. Barufaldi, 2008) in classrooms creating beliefs or images about students as passive learners, only seeing instruction from a student's perspective. Lortie defines this as "apprenticeship of observation" (1975, p. 61) and emphasizes experiences of classroom teachers with "[t]hose who teach have normally had sixteen continuous years of contact with teachers and professors. The interaction…is not passive observation-it is usually a relationship which has consequences for the student and thus is invested with affect" (p. 61). Most likely these experiences have occurred in traditional classrooms, and resulted in the formation of "tacit" (Kagan, 1992, p. 66) knowledge or beliefs-often unknown or unrecognized by preservice teachers. As beliefs are reinforced by repeated experiences that do not confront

or contradict the belief itself, preservice teachers form strongly held beliefs that are difficult to change (Abelson, 1979; Nespor, 1987; Pajares, 1992; Rokeach, 1968). Many of the passive experiences, undoubtedly become part of an individual preservice teacher's "episodic memory" (Abelson, 1979), or result in the formation of specific images of teachers, teaching, lessons, and student learning.

BELIEFS AND IMAGES OF TEACHING ACT AS FILTERS

Most importantly, beliefs, or images of teaching, act as filters (Calderhead & Robson, 1991; Yerrick, Parke, & Nugent, 1997) through which preservice teachers make sense of new information, and learn from new situations. Too, "[i]mages, whether representations or reconstructions, provide us with an indicator of teachers' knowledge, and enable us to examine the knowledge growth attributable to different training experiences and the relationship between knowledge and observed practice" (Calderhead & Robson, 1991, p. 3). Teacher educators need to know what beliefs preservice teachers bring with them into teacher education programs, in order to plan appropriate experiences and lessons to facilitate reflection on existing beliefs in light of new information, and to create a space in which change may occur.

Indeed, eliciting and understanding existing images and beliefs held by preservice teachers as they enter into a teacher education program is important for teacher educators. Once these images or beliefs are known, lessons and experiences may be crafted which, through reflection, may allow preservice teachers to review their existing image or belief in light of new information or experiences.

As mentioned above, beliefs and their respective belief systems act as filters toward new information. The filters guide interpretation of new information (Yerrick, Parke, & Nugent, 1997), and ultimately, filters guide new learning. Beliefs will ultimately filter learned information, as it is recalled. Therefore, a filter, then ultimately

impacts the understanding of an individual, and the construction of new constructs resulting from education.

When instruction requires evidence for learning (formative assessment), an instructor must begin with an individual's prior knowledge (Green, 1971) which will then be used to craft the initial instruction that targets existing beliefs (Bryan & Abell, 1999). According to Fortney and Barufaldi (2008), the beliefs and images that preservice teachers bring with them to their teacher education program are important to understand, as then "appropriate experiences" (p. 6) can be crafted to facilitate reflection upon (and evaluation of) existing images and beliefs to create a "space" for potential change (B. Fortney & J. Barufaldi, 2008, p. 6).

COMPETING DEFINITIONS OF BELIEF

While there is no general agreement in the definition of "Belief" (Nespor, 1987; Pajares, 1992; Richardson, 1996; Thompson, 1992), there are some commonly used definitions. Two often used definitions are derived from Rokeach (1968) and Fishbein and Ajzen (1975). For example, Rokeach defines beliefs as "…inferences made by an observer about [an individual's] underlying states of expectancy" (Milton Rokeach, 1968, p. 2). "Underlying states of expectancy" are described by Rokeach as images that guide understanding and sense-making. One of the lenses in this research seeks to infer an individual's underlying states of expectancy, or expectations. These underlying states of expectancy shape the expectations an individual uses to compare and evaluate situations, which in this case means classroom situations. It is these expectations that Bryan and Abell report as causing tension between Barbara's expectations of what Mrs. Clark should do (according to Barbara's expectations and beliefs) and Barbara's observations of what Mrs. Clark actually did in the classroom. The underlying states of expectancy used for comparison purposes also drive an individual's expectations, and also convey

information about an individual's beliefs. The underlying states of expectancy may also provide insights into classroom practice of teachers.

	Cognition	Affect	Intended Behavior	Actual Behavior
Descriptive Belief	1	4	7	10
Evaluative Belief	2	5	8	11
Prescriptive Belief	3	6	9	12

Table 2.1: Conceptual framework used to synthesize research (M. Fishbein & I. Ajzen, 1975; Milton Rokeach, 1968)

A second example of a commonly used definition is the one by Fishbein and Ajzen. They define a belief as "…the subjective probability of a relation between the object of the belief and some other object, value, concept, or attribute" (M. Fishbein & I. Ajzen, 1975, p. 131). "Subjective probability" may be interpreted as being synonymous with expectation. The link *is* the expectation, regardless of the terminology used.

Whatever definition is preferred, the call for careful research exists to elucidate belief constructs (Pajares, 1992) held by preservice teachers as they learn to teach, and begin to teach professionally. For example, a belief construct may also be called a belief structure (Pajares, 1992; Posner et al., 1982; Strike & Posner, 1985, 1992), and can be thought of as connections of importance between beliefs (Milton Rokeach, 1968). The connections begin to make abstract (conceptual) connections more tangible. These connections, then, may be thought of as the structure of knowledge (Nespor, 1987; Roehler, Duffy, Herrmann, Conley, & Johnson, 1988) held by an individual, and represented as connections between and among beliefs (Chi et al., 1994; Fellows, 1994; Posner et al., 1982; Thompson, 1992; Vosniadou, 1994). The reader will note, internal consistency (consistency between beliefs) is not required within an individual's belief

system (Nespor, 1987), as beliefs may be held in isolation from one another (L. A. Bryan, 2003; Nespor, 1987; Milton Rokeach, 1968). These sub-constructs may be called belief sub-structures (Bandura, 1986).

Given that beliefs provide insight into teacher thinking (Nespor, 1987), as well as providing insight into the practice of teachers (Hashweh, 1996; Richardson, 1996; Richardson et al., 1991), there must be a significant attitudinal component linking the belief with a behavior (Green, 1971; Milton Rokeach, 1968, p. 126) if there is to be a change in attitudes and behaviors (Milton Rokeach, 1968, p. 133). Too, since beliefs have been shown to be resistant to change (Pajares, 1992; Richardson, 1990), beliefs that are not in line with classroom practice need to be targeted (Simmons et al., 1999).

Table 2.1, above, has been arranged to aid in the selection of methods that fit well into an elementary science methods course. The main goal of this selection process is to operationalize Rokeach's (1968) definition of belief, making the combination of experiences and assignments (selected by teacher educators) fit together to aid preservice teachers in identifying their prior beliefs and images of teaching science, and as a guide to teacher educators in helping preservice teachers make sense of new experiences in light of their prior experiences. It also contributes to the literature base of teacher education in that it facilitates conversations between researchers who use different definitions of belief. For example, Nespor (1987) differentiates between knowledge and beliefs. Nespor associated knowledge with cognition (column 1, box 1), with knowledge being schematically organized. Nespor does not specifically address cognition with respect to evaluation or advocating future action (boxes 2 and 3); however, his definition does not rule evaluation or advocating future action out as Nisbett and Ross do (Nisbit & Ross, 1980). Nespor's belief construct contains affect (feelings for something), and differentiates beliefs from knowledge on the basis of four characteristics. They are:

existential presumptions, the personal truths that everyone holds about themselves that are incontrovertible (p. 309), alternativity, the creation of alternate realities that may correspond to an ideal, the affective and evaluative nature of beliefs, and, different from knowledge, beliefs are episodically stored as episodes or images that can be accessed separately from knowledge that is stored semantically. These can be represented by column 2, in Table 2.1.

Further describing Table 2.1, once longitudinal data have been gathered on the basis of each box, it can be viewed with respect to Ajzen's theory of planned behavior (Ajzen, 1985), Fishbein and Ajzen's theory of reasoned action (I. Ajzen & M. Fishbein, 1980), or Rokeach's (1968) conception of belief organization and change.

USE OF EXISTING METHODS IN NEW WAYS

Due to at least a decade of research, one may assume that a common agreement exists amongst teacher education researchers. Indeed, the literature supports this agreement. The agreement includes: beliefs are formed from experience, and teacher beliefs guide their practice and decisions about what material to use, and how it is implemented in the classroom. Beliefs include the teacher's philosophy of teaching, the pedagogy selected and the type of question asked of students. These experiences are crucial in the formation of beliefs about teaching.

For teacher educators, few would disagree that the experiences future teachers have in education are important. For example, in Richardson's (1996) piece, she explains: "life experiences" (p. 106) in some way guide or shape the formation of robust beliefs that persist through contemporary instruction. Therefore, it is these beliefs that need to be "surfaced and acknowledged" if the "deep structure of knowledge and beliefs" (p. 106) are to be influenced or changed throughout a teacher education program. Existing methodologies need to be conceptualized differently, or possibly conceptualized with

combinations of existing measures used for making more robust belief inferences, and subsequent instruction created to target existing teacher beliefs (Kagan, 1990; Pajares, 1992; Richardson, 1996).

Kagan (1990), in her review, suggests that a combination of different methods from different research paradigms allow sufficient data to be collected for researchers to triangulate findings, as well as "capture the complex, multifaceted aspects of teaching and learning" (p. 459). In this research, different methods from different paradigms were selected to combine the deep, colorful nature of qualitative research techniques that *seek to explain* a phenomenon, or *describe* an experience, with descriptive or statistical methods and techniques from quantitative research methods that look for trends.

Most often, quantitative methods require large sample sizes, and seek to generalize findings to a larger population, or to formulate theory. Therefore, the strengths of each method help to offset and augment the weaknesses of the other method. In this research, quantitative data provide perspective on the cohorts that were comprised of the participants from this study, as well as detail how each individual participant relates to their peers. Too, qualitative data, such as interview data, provides the rich detail that comprises the foundation for belief inferences (inferences about each participant's beliefs about teaching and student learning in elementary science), as well as individual participant's reflection on changes in their beliefs with respect to the instruction received in their university science methods course.

The multi-method approach discussed below and used in this research has been developed to include mixed methodological research designs (see for example Creswell & Plano Clark, 2007; A. Onwuegbuzie & Teddlie, 2003). The design for this research—a mixed methodological triangulation design for convergence was chosen to allow qualitative data to be merged with quantitative data (Creswell & Plano Clark, 2007).

Pajares (1992) cautions researchers, and in so doing, poses a challenge to the field. His caution—any new research is unlikely to be informative unless belief inferences and assessments take into account an individual's belief statements, behavioral intentions and actual behaviors in a situation (with respect to a specific belief), as well as the initial images of teaching held by pre-service teachers (p. 315). In other words, new research must take into account what preservice teachers "say, intend, and do" (Pajares, 1992, p. 316). New research must take into account existing beliefs, existing images, and prior-knowledge held by preservice teachers as they enter into preservice teacher education programs—in order to effectively plan for instruction that seeks to change prior traditional beliefs about teaching.

New research must also take into account the strength of knowledge gained through experience in K-16 classrooms. For example, the "apprenticeship of observation" (Lortie, 1975, p. 61) emphasizes such (prior) experiences of classroom teachers. According to Dan Lortie (1975), a majority of teachers have had "sixteen continuous years of contact" (p. 61) with instructors as they, themselves were students in classrooms. The teacher-student bond that develops includes more than just knowledge gleaned from "passive observation" (p. 61). It includes images of teaching that are deeply seated within the future teacher's existing repertoire, and are strongly held for many reasons, including the personal relationship based on respect that has been carefully cultivated by the sheer nature of teacher-student professional relationship (p. 61).

Most likely, such experiences have occurred in traditional classrooms, and resulted in the formation of "tacit" (Kagan, 1992, p. 66) knowledge or beliefs-often unknown or unrecognized by preservice teachers. Tacit knowledge is knowledge that lurks behind the scene, and may not be active in an individual's consciousness, or recognized in the decisions that a teacher makes in the classroom. Making this tacit

knowledge visible to individual classroom teachers is very important in understanding why teachers make the decisions they make.

The argument for development of deep-seated, robust beliefs (tacit or otherwise) that are reinforced through repeated experience, continues. As beliefs are reinforced by repeated experiences that do not confront or contradict the belief itself, preservice teachers form or reinforce strongly held beliefs that become more difficult to change (Abelson, 1979; Nespor, 1987; Pajares, 1992; Milton Rokeach, 1968). Passive experiences, then, undoubtedly become part of a preservice teacher's "episodic memory" (Abelson, 1979), memory stored in the form of visual episodes (not descriptive) that result in the formation of specific images about teaching, and the role of the teacher in the classroom. The images include images of teachers (most likely underpinned by respect), images of teaching, images of lessons and the *progression* of individual lessons, as well as images of student learning.

It is these very images and beliefs—formed through direct experiences—that act as filters (Calderhead & Robson, 1991; Yerrick et al., 1997). As new information is encountered, it is interpreted (filtered) and made sense of through the use of past experiences. The past experiences allow individuals to learn new information from new situations, but it also may hinder the learning of new information if it is out of context, or very different from the experiences held by the individual. For example, a practicing teacher, well versed in the art of traditional teaching methods (i.e. direct instruction, where the teacher is the provider of information), will interpret in-service instruction on constructivist teaching pedagogy (such as inquiry in the science classroom) very differently from a practicing teacher who already has an introduction to constructivist teaching pedagogy. Thus, including methods that uncover the foundational images and beliefs held by preservice teachers is important.

The teacher who has an introduction to constructivist teaching pedagogy already understands that information is not *given* to students (such as in a transmission model). Each student actively constructs her or his own understanding through various interactions, with the teacher helping to guide or mediate student learning. The traditional teacher, most likely, views the nature of classroom interactions from a passive stance in that students are quiet, and do not interact (much) with their peers. Thus, from this standpoint, individual construction of knowledge is passive.

To further develop the importance of using existing methods in new ways, our attention turns to the discussion on images, specifically, to Calderhead and Robson (1991). Calderhead and Robson discuss the use of images of teaching, held by practicing teachers. The images, developed from transcripts or other methods, are valuable indicators of the knowledge held by teachers about teaching and student learning in classrooms. Any *changes* in the images held by classroom teachers are important in that the changes may then be linked to various experiences and techniques (such as reflection) used in pre-service or in-service teacher education programs. (p. 3)

Because of the importance of prior knowledge, existing images, and beliefs about teaching, teacher educators need to know what images and beliefs preservice teachers bring with them into teacher education programs in order to plan appropriate experiences and lessons to facilitate reflection on existing beliefs in light of new information, and to create a space in which change may occur. Additionally, teacher educators need to be able to resolve changes in underlying images and conceptions held by preservice teachers in order to appropriately make the decision of what to implement to further student understanding. Thus, combining existing instruments to provide specific data is important.

IMPORTANCE OF BELIEFS ON PRACTICE

Teacher educators should care because research on science teaching has advanced. This, combined with advances in cognition research, and new research into learning, makes the call for use of methodologies in different ways (Pajares, 1992; Richardson, 1996) approachable. Specifically, methodological advances (Creswell, 2007; Creswell & Plano Clark, 2007; A. Onwuegbuzie & Teddlie, 2003) allow for the use of existing methodologies in new ways that culminate to be more "research friendly," and applicable for teacher educators in that the new research friendly methodologies help to bridge the research-practice divide.

Japanese Lesson Study (JLS) (Lewis, 2002), was chosen to address the above points by providing structure for individual reflection on authentic classroom experiences, and social negotiation of knowledge that provides a rich opportunity for identification *of*, reflection *on*, and opportunities *for* change. Preservice teachers take an active role in setting goals, gathering data through observation of their peers and self (via videotape), and engaging in a deeply reflective process centered around teaching and their personal understanding of teaching and learning from multiple perspectives. "This type of reflective framework is rare in U.S. teacher education programs" (Darling-Hammond & Ball, 1998; C. Lewis et al., 2006). The use of JLS provides the grounds for identification *of*, and reflection *on* preservice teacher beliefs about teaching and learning, by preservice teachers themselves. Therefore, the significance of this research is that it portrays research centered on a course that is exemplified by the following quote:

> If a program is to promote growth among novices, it must require them to make their preexisting personal beliefs explicit; it must challenge the adequacy of those beliefs; and it must give novices extended opportunities to examine, elaborate, and integrate new information into their existing belief systems" (Kagen, 1992, p. 77, as quoted in Jones & Carter, 2007, p. 1082).

SUMMARY

In sum, eliciting and understanding existing beliefs and images held by preservice teachers as they enter into a teacher education program is important for teacher educators. For, once these images or beliefs are known, lessons and experiences may be crafted which, through reflection, may allow preservice teachers to review their existing image or beliefs in light of new information or experiences.

Chapter 3: Methodology

OVERVIEW AND CHAPTER INTRODUCTION

The purpose of this study is to investigate existing beliefs and images of teaching held by preservice teachers, through the use of the Japanese Lesson Study protocol. In theory, by eliciting foundational beliefs held by preservice teachers and encouraging them to reconcile their existing beliefs with new instruction and new experiences with practice lessons, a longer lasting and more robust change in beliefs about teaching and learning will be effected (Abell & Bryan, 1997; Cooney et al., 1998).

A conceptual framework has been developed based upon two instrumental exploratory studies (Stake, 1995) that focused upon the following ideas: First, the exploratory studies sought to develop and understand the construct of beliefs about teaching and student learning in science, and belief structure within the context of a preservice teacher education program, specifically an elementary science methods program. Second, based on the conceptualization of preservice teacher beliefs about teaching and student learning in science and subsequent belief structure (Cooney et al., 1998; Milton Rokeach, 1968), data were gathered such that inferences may be made from individual data to infer the foundational beliefs held by individual preservice teachers, and resolve a structure (Cooney et al., 1998; Green, 1971; Perry, 1999; Milton Rokeach, 1968) with respect to the foundational beliefs held by individual preservice teachers. Green (1971) suggests a three-category scheme for evaluation that indicates connectivity of beliefs and their location within a system. The schema: whether beliefs are held centrally or peripherally in the belief system, whether they are primarily or derivative, or held in clusters and isolated from other beliefs in the individual's belief system. Based on

this structure, preservice teacher belief structures were inferred, and used to understand the intentions and actions of preservice teachers in relation to new information.

Data were gathered over three separate, unequal, time periods over the course of an eighteen-week semester, conceptualized to fit within a Lesson Study (C. C. Lewis, 2002) protocol. The first time period was designed to elicit belief statements, images of teachers, and knowledge of teaching and student learning in elementary science classrooms. This provided data for inferences about preservice teacher prior conceptions- a baseline of sorts. Too, the assumption was that none of the preservice teachers in the cohort had experience in planning for or teaching science lessons, reform-based or otherwise. The assumption that none of the preservice teachers planned or taught science lessons was found to be accurate, as was the assumption that few participants in the study observed the teaching of any elementary science lessons since they enrolled in the university. This is important, as Lesson Study protocols require groups of practicing teachers to collectively plan a lesson. Due to the two assumptions discussed above, original instruction regarding planning for reform-based lessons was included in the baseline time period, with the regular Lesson Study protocol including re-planning of lessons carried out between the pre-lesson study, and the post-lesson study data collections.

The baseline, pre-lesson study, and post-lesson study time periods were then analyzed with respect to each participant's beliefs, and subsequent determination of belief structure. Specifically, structure, within the context of beliefs, is defined as the consistency of participant actions, intentions, and statements with respect to their foundational beliefs, and intentions. Thus, addressing the two research questions: 1. *Do pre-service teacher belief structures change during the implementation of a Japanese*

Lesson Study cycle? If so, how and to what degree do they change? 2. *To what extent are preservice teachers teaching behaviors consistent with their belief structures?*

Data gathered were selected on the basis of a conceptual framework, that was designed to fit Fishbein and Ajzen's theoretical framework within the context of a teacher education program. Rokeach's three types of belief were utilized to operationalize Fishbein and Ajzen's framework within the context of a teacher education program. In other words, as data were gathered in collaboration with preservice teacher participants, participants were asked to describe, evaluate, and ascribe future actions to various lessons, scenarios, and activities with elementary students, thus, serving to triangulate preservice teacher foundational beliefs and conceptions of teaching science, and the role of the teacher. Fishbein and Ajzen's theoretical framework holds that an individual's behaviors are based on reasoned actions, based on cognition (thinking about actions-in this case teaching behaviors contained within a lesson), and affect (feelings about performing that behavior). "Consequently, the best predictor of a particular behavior is the individual's intention to perform the behavior" (D. O. Shaffler, 1990, p. 61). While this research does not seek to predict preservice teacher behaviors, it does seek to elicit and infer underlying foundational beliefs held by preservice teachers. See also work by Koballa (1986).

Therefore, the conceptual framework guided the selection of methods in that each intersection of the matrix (Tables 1.1 and 2.1) required specific data to aid in the resolution of foundational beliefs, and resulting structure between beliefs. Ultimately, the chosen method, instrument, and question matching are provided in Tables 3.2 and 3.3. Quantitative instruments included the revised Constructivist Learning Environment Survey (Johnson & McClure, 2004), and Stages of Concern-Quantitative survey (G. E. Hall, George, & Rutherford, 1998), both Likert-scale surveys completed at various

intervals as corresponding to the three data collection time periods. Qualitative data were collected primarily from formal, semi-structured interviews (once per data collection period), teaching observations (during Phase Two of the Lesson Study protocol), multiple individual and group reflections, and debriefing meetings, as well as other artifacts. (A complete listing may be found in Figure 3.2.) Final merging of quantitative and qualitative data, case-building, and cross-case analysis occurred after the eighteen-week semester, within which Lesson Study was the primary case, and foundational aspect to the elementary science methods course.

Typology of Mixed Methods Research

The design of this dissertation research is of fully mixed, concurrent, equal status design (Leech & Onwuegbuzie, 2005, p. 11) for triangulation of belief inferences (Creswell, 2003), and is based on a baseline/pre/post time sampling schema. Three preservice teachers in all-selected from two groups of three-were purposefully selected as a subset of the larger collective case study (n=25) in that the researcher was present at all planning, teaching and reflection sessions (and did not depend on video for observation of teaching episodes) thus reducing the credibility threat to findings through prolonged engagement in the field (Anfara, Brown, & Mangione, 2002). Because the researcher was present at all sessions with all group members, a common experience was shared. Preservice teacher background, demographics, and experiences were very diverse, yet similarities exist that provide for interesting comparisons.

While concurrent in nature, the overall mixed methods research design holds both qualitative and quantitative elements with approximately equal weights. Since this is a fully mixed concurrent equal status design, qualitative and quantitative methods are mixed within one or more, or across the following four components: the research objective, type of data and operations, type of analysis, and type of inference (Leech &

Onwuegbuzie, 2005, p. 11). At the end of the fifteen-week study, qualitative and quantitative data were mixed for interpretation and inference of beliefs, and subsequent structure. Since the methods were gathered during three contiguous time periods in a baseline/pre-/post time sampling schema, this provided the insight into designation of change, thus addressing the research questions.

In this study, the type of data and operations, type of initial analysis, and type of inferences vary according to the construct validity of each instrument, as well as legitimacy of qualitative data, with each contributing data to offset the limitations of the other instruments. For example, a 20-question, Likert-scale survey, the revised, Constructivist Learning Environment Survey, was used to assess the perceptions of both preservice teacher participants (individual and peer perceptions) and course instructor. Thus, this provides an aspect of trustworthiness such that internal credibility threats are reduced in that several perspectives are provided to mediate self-report data, and guard against researcher bias, descriptive validity or "factual accuracy of the account as documented by the researcher" (A. J. Onwuegbuzie & Leech, 2007, p. 235), as well as guard against observational bias (A. J. Onwuegbuzie & Leech, 2007).

Case definition

Stake (1995) makes the distinction between intrinsic case studies and instrumental case studies. Research in which the case (Θ) is more important than the issue (ϑ_1) is an intrinsic case study. Likewise, research in which the issue or issues are more important is termed an instrumental case study. In this research (full study), the case (Θ = Lesson Study) is of primary importance, thus, it is an intrinsic case study. The reader will note that each individual preservice teacher's case must be explored and understood in depth, in order to address the primary case of Lesson Study. The issues of separating the individual case from the case of Lesson Study will be further explained in chapter 5. The

two exploratory (intrinsic) case studies that contributed to the design of this study and understanding of belief constructs used within this research had different goals; thus, the issue (ϑ_1), in the exploratory studies, was more important in contributing to the synthesis of the conceptual framework used in this study.

Conceptual Framework

The theoretical perspective from which I conceptualize my research is an interpretivist framework grounded within a Realist ontology (Crotty, 1998). The interpretivist perspective seeks to understand the beliefs and actions of an individual by eliciting an individual's personal perspective, as well as seeking to understand the meaning each individual ascribes to various situations, beliefs, and actions. Specifically, this research seeks to understand an individual's beliefs about teaching and student learning in a science classroom.

Discussion in chapters 4 and 5 is consistent with the interpretivist perspective, and is framed by the assumptions of the Concerns Based Adoption Model (CBAM) (G. E. Hall et al., 1998; Hord, Rutherford, Huling-Austin, & Hall, 1987). This research embraces the assumptions of the CBAM in that it seeks to understand the beliefs, images of teaching, and concerns preservice teachers use to make sense of new information in their university courses. Since empirical evidence indicates that beliefs guide practice (Kagan, 1992; Nespor, 1987; Pajares, 1992; Richardson, 1990), guide the teacher's selection of teaching methods and materials (Keys & Bryan, 2001), and guide teacher response to student questions, an understanding of how preservice teachers beliefs and concerns change throughout one semester of a contemporary elementary science methods course is an important beginning in the understanding of belief change, or resolution of processes or pathways for belief change (Kagan, 1992).

Table 3.1 summarizes the major assumptions that underpin the theoretical framework of the CBAM, and sets the stage for discussion of beliefs, and belief structures held by individual preservice teachers. Additionally, the CBAM is consistent with Francis Fuller's work (1969; 1970), and creates space for understanding of individual interpretations of course material with respect to personal definitions of learning and understanding—fundamental ideas forming the backbone of reform-based teaching in American classrooms. Thus, because belief change is assumed to be deeply personal, highly idiosyncratic, and fraught with pitfalls in inference-making, the CBAM was selected as a framework that provides the following guiding assumptions (Hord et al., 1987, p. 6):

Table 3.1: CBAM assumptions

Table 3.1: CBAM Assumptions (p. 6)	Definitions
1. Change is a highly personal experience	Therefore belief elucidation is important.
2. Change is accomplished by individuals	Hence "crafting" experiences for exposing foundational beliefs is important.
3. Change is a process not an event	Process: Learning to teach science is a process, which occurs over time, and not a single event. (p. 6)
4. Change is best understood in operational terms	Operational-what needs to be collected/done to understand change?
Guiding question from 4: What changes in their [preservice teacher's] own or their students' values, beliefs, and behavior will [reform-based instruction] require?	Innovation: Learning to teach elementary science in a constructivist manner, in which the "teacher and students are encouraged to think and explore." (Brooks & Brooks, 1999, p. 30)

The basis of this research that meshes with the above assumptions is the understanding of beliefs that preservice teachers use to interpret new instruction and make sense of classroom situations. Too, since this research seeks to identify specific images of teaching that preservice teachers use as a model of teaching, the idea is that as

the image changes, the change may be indicative of changes in underlying beliefs preservice teachers hold about teaching and learning in science. This, accompanied by changes in preservice teacher concerns, provide deeper insight into what preservice teachers attend to as they learn to teach in a new way.

Because change is accomplished by individuals, and is a highly personal experience (Hord et al., 1987, p. 6), a lens of individual change, with respect to preservice teacher prior knowledge, is used to interpret prior experiences, existing conceptions (and images) of teaching, and well as conceptions of student learning. Too, change deals with participant epistemology, beliefs and prior knowledge, a definition of belief is appropriate that is consistent with this research (Calderhead, 1996; M. Fishbein & I. Ajzen, 1975; Hashweh, 1996; Milton Rokeach, 1968).

Past research on beliefs has been conducted within different research frameworks (theoretical, practical, or conceptual (Eisenhart, 1991)), and has used differing definitions of belief, as well as having been constructed with differing philosophies (of learning). Each of these aspects, including the philosophy of learning, and differing definitions of belief has also limited the synthesis of findings. For example, if the philosophy of learning of the teacher educator (or researcher) is to present a variety of lessons to students, then they most likely subscribe to an implicit teaching style to impart lesson planning perspectives through the activities, termed "activity-oriented" (See Anderson and Smith cited in Abell and Bryan 1997, p. 154). If, however, the teacher educator's definition is consistent with a philosophy of empowerment, then preservice teachers will be continually challenged to take control of their own learning, and learn to be proactive in identifying *why* they feel the way they do, and the *reasons* they have for exhibiting the behaviors that they exhibit. Preservice teachers will be explicitly encouraged and helped

to formally recognize their pre-existing image of teachers and teaching, as well as the beliefs that underpin and control their decisions.

In the case of this research, different perspectives are embraced to guide research through the merging of different research methods. They were carefully selected in order to triangulate findings through convergence (Creswell & Plano Clark, 2007; Pajares, 1992; Richardson, 1996), and to achieve different results that transcend research traditions (Pajares, 1992; Richardson, 1990).

This research seeks to combine traditions to seek answers to the following *how* and *why* questions: How do preservice teachers make sense of new information in light of prior knowledge, and images of teaching? Why do preservice teachers choose attention to some details of teaching and not others? To what extent do preservice teachers engage in instruction and instructional activities with respect to their prior knowledge and image of teaching and teachers? What reasons do preservice teachers give for the above? The type of findings will be specific to either qualitative or quantitative traditions. Specifically, the quantitative tradition (not necessarily positivistic research) provides specific information regarding probability of occurrence. For example, Rokeach (1960) during the tenure of the positivist research paradigm, attempted to determine the importance of a given belief by systematically varying beliefs (through hypnosis) one at a time. Current research, while it may be similar, most likely seeks to understand reasons for change. Thus, it requires qualitative methodology to some degree.

Qualitative methods, as mentioned, seeks to understand *how* questions (Richardson, 1992), for example How do preservice teachers make sense of new information in light of their existing beliefs and knowledge? As a second example, qualitative research may also seek to link reflection with belief change. An example, how does reflection impact the images and beliefs held by preservice teachers? Qualitative

research also seeks to understand *why* questions (Richardson, 1992). For example, *why* do preservice teachers use some of their prior information at some instances and not in others? Because this research seeks how and why questions pertaining to an individual's beliefs, a case study methodology is appropriate. The rationale for the use of case study methodology is to seek an understanding of an individual's beliefs that is achieved through the use of inferences about beliefs. A case study methodology makes obvious sense.

Since many have called for the use of existing methodologies in new ways (See, for example, Richardson 1990, Pajares, 1992), with the making of belief inferences a difficult undertaking, a mixed methods approach is appropriate. Mixed methods use is tied to beliefs research in that belief inferences must be triangulated from multiple sources.

Use of existing methods in new ways

Due to at least a decade of research, one may assume that a common agreement exists amongst teacher education researchers. Indeed, the literature supports this. The agreement is that teacher beliefs are important in that they guide many things a classroom teacher does. From the philosophy that is used in the classroom, to the pedagogy selected for a specific domain, to the type of question asked of students, that teachers provide these experiences is crucial in the formation of beliefs about teaching.

For teacher educators, few would disagree that the experiences future teachers have in education are important. For example, in Richardson's (1996) piece, she explains: "life experiences" (p. 106) in some way guide or shape the formation of robust beliefs that persist through contemporary instruction. Therefore, it is these beliefs that need to be "surfaced and acknowledged" if the "deep structure of knowledge and beliefs" (p. 106) are to be influenced or changed throughout a teacher education program. Existing

methodologies need to be conceptualized differently, or possibly conceptualized with combinations of existing measures used for making more robust belief inferences, and subsequent instruction created to target existing teacher beliefs (Kagan, 1990; Pajares, 1992; Richardson, 1996).

Additionally, Kagan (1990), in her review, suggests that a combination of different methods from different research paradigms allow sufficient data to be collected for researchers to triangulate findings, as well as "capture the complex, multifaceted aspects of teaching and learning" (p. 459). In this research, different methods from different paradigms were selected to combine the deep, colorful nature of qualitative research techniques that *seek to explain* a phenomenon, or *describe* an experience, with descriptive or statistical methods and techniques from quantitative research methods that look for trends. Most often, quantitative methods require large sample sizes, and seek to generalize findings to a larger population, or to formulate theory. Therefore, the strengths of each method help to offset and augment the weaknesses of the other method. In the case presented below, quantitative data provide perspective on the cohorts that were comprised of the participants from this study, as well as detail how each individual participant relates to their peers. In addition, qualitative data, such as interview data, provides the rich detail that comprises the foundation for belief inferences (inferences about each participant's beliefs about teaching and student learning in elementary science), as well as individual participant's reflection on changes in their beliefs with respect to the instruction received in their university science methods course.

The multi-method approach discussed below and used in this research has been developed to include mixed methodological research designs (see for example Creswell & Plano Clark, 2007; A. Onwuegbuzie & Teddlie, 2003). The design for this research—a

mixed methodological triangulation design for convergence was chosen to allow qualitative data to be merged with quantitative data (Creswell & Plano Clark, 2007).

EXPLORATORY STUDY FINDINGS AND GOALS

Exploratory Study 1

Goals

Goal 1: To understand the constructs of beliefs about teaching science and beliefs about student learning in science, as they pertain to preservice teachers in an elementary science methods course.

Sub goal: To understand the use of methods needed to provide data for realizing individual preservice teacher belief constructs about teaching and student learning in science.

Several findings came to light. First, the various methods selected are appropriately used with preservice teachers provided the expectation of sophistication in provided answers is commensurate with preservice teacher level of experience. Second, data obtained by standard techniques may be augmented by having preservice teachers describe what they will do pedagogically and in their instruction, describe their intentions with respect to responding to student questions and actions, and reflect upon their actions with respect to their description of the lesson and intended actions. This will help to provide information specific to the constructs in question.

Goal 2: To understand the specific beliefs preservice teachers hold as they enter into the professional development sequence, and the experiences that led to the formation of those beliefs.

Sub goal: To understand how preservice teachers make sense of new information in light of their existing beliefs.

The findings relative to this goal and sub goal include a diverse set of experiences centered around traditional instruction in elementary grades, with a few exceptions. Occasionally, an exceptional teacher stood out to a participant, which provided a different image of a science teacher, as well as a different standard to apply to classroom experiences. However, regardless of this different image, the predominant understanding of preservice teachers created struggles as they attempted to interpret this image of a science teacher (or scientist). The primary struggle appeared to be with their standard of evaluation. Even though this instance stood out, preservice teachers lesson plans did not reflect a reform-based pedagogy. Their lessons most resembled lectures, or traditional instruction.

Goal 3: How to determine and define "change." Change in beliefs is difficult to conceptualize. A more robust method of evaluating change was determined to be needed, leading to the addition of the Draw A Scientist activity (Thomas & Pedersen, 2003).

Findings

A 2006 exploratory study (Fortney, B. & Barufaldi, J., 2006, January 12-14) found that the instructor and students held very different conceptions of constructivist learning environments, thus stressing the need for "researcher reflexivity" (Brantlinger, 2005), and an instrument such as the Constructivist Learning Environment Survey. The reasons that probably contribute to the different responses may be attributed to several factors. Some factors include the following: a) instructor/researcher bias: the instructor/researcher is white, male, monolingual, and has 8 years of secondary Chemistry and Physics instruction in public schools-4 being in Urban settings that were shaped by 4 months of intensive Urban education apprentice teaching and related coursework and experiences, as well as specific cultural experiences; b) course setting: a field-based, bilingual teacher education program housed in an urban elementary school

with instructors driving from the university to the public school setting (participants are embedded within the elementary school); c) participant gender: >90% female[3]; d) language, all students are required to have passed written and oral fluency tests in Spanish and English before entering the Cohort. The CLES instrument was chosen to address the trustworthiness of data, gain multiple perspectives regarding lessons as they are taught in bilingual classrooms, and facilitate opportunity for elucidating and assessing multiple conceptions and bias through empirical, quantitative (descriptive) data in the form of box and whisker plots. Missing data points were replaced with the mean of the particular subsection. The five subsections are defined by Johnson and McClure (2004) as: learning about the world (Personal Relevance); learning about science (Uncertainty); learning to speak out (Critical Voice); learning to learn (Shared Control); learning to communicate (Student Negotiation). In pairs, these subsections contribute to three constructs—each contributing the perceptions of the instructor, and each group member. The constructs are: knowledge of students, knowledge of pedagogy, and knowledge of content.

The unpublished 2005 exploratory study by this author suggested that different perspectives are needed for the instructor/researcher to gain access to student conceptions of constructivist learning environments. The instructor/researcher feels that he understands 75% of the Spanish used in K-4 classrooms, and is aided in the fact that all lessons were co-planned as a learning activity within groups following the Japanese Lesson Study protocols as related by Catherine Lewis (Lewis, 2000). Also contributing was the realization that participants often included statements about "things that concerned them." Therefore, the open-ended Stages of Concern survey was added (George, 1978).

[3] Percentages have been altered to help with the de-identification of participants.

Exploratory Study 2 overview

The second exploratory study was guided by three goals. Most were directly related to the first Exploratory study. They included attempts at operationalizing data collection into the science methods course by asking preservice teachers to relate what they "think, say, and do" (Pajares, 1992, p. 316) with respect to their beliefs, and the lessons that they planned and implemented. This made the data more meaningful to preservice teachers. A second goal was to practice implementation of methodology, and further develop the constructs of teacher beliefs about teaching elementary science, and teacher beliefs about learning in science. Should any gaps occur, they provide direction to make methodological changes. In fact, the theoretical framework that emerged from the two exploratory studies did indeed have gaps in evidence. Specifically, boxes 3, 6, and 9 were blank (Table 2.1), and did not have any data collected to address prescriptive beliefs held by preservice teachers. Prescriptive beliefs have preservice teachers advocate for specific actions in given situations. This is at the heart of reflection on the differences between intended and actual behaviors. These gaps were addressed with the addition of prescriptive prompts, which will be addressed below. Additionally, the Open-ended Stages of Concern survey was found to not provide enough information, which was consistent with findings from George, Hall, and Stieglebauer (2006). Therefore, the Likert-scale Stages of Concern instrument was added, with the open-ended prompts used for triangulation of concerns data.

SUMMARY OF EXPLORATORY STUDY FINDINGS

As guided by the two exploratory studies, an additional instrument was added, which is the quantitative version of Stages of Concern (SoCQ) questionnaire, a 35-question unipolar, response measure in the form of a Likert scale instrument. According to Fishbein and Ajzen's (1975), definition of belief which links an object with an

attribute, this questionnaire links the object (the preservice teacher) with the attribute listed in the question (the concern). Additionally, individuals' belief statements, their lesson plans, and their prescriptive statements, shed light as to "…the intentionality to behave in a predisposed manner, and the behavior related to the belief in question." (Pajares, 1992, p. 326) Pajares continues:

> "Because they [belief sub-constructs] are specific enough to be reasonably operationalized and more easily measured, belief subconstructs, such as self-efficacy, lend themselves more readily to educational research. But, because they offer a limited glimpse into a much broader system and because understanding their connections and centrality is essential to understanding the nature of their effect, researchers must study the context-specific effects of beliefs in terms of these connections. Seeing educational beliefs as detached from and unconnected to a broader belief system, for example, is ill advised and probably unproductive." (1992, p. 326) "It is important to think in terms of connections among beliefs instead of in terms of beliefs as independent subsystems and to conceptualize belief models in ways that make research findings clearer and more accurate reflections of their aims and of the construct. When carefully conceptualized, when educational beliefs and their implications are seen against the backdrop of a broader belief structure, inconsistent findings may become clearer and more meaningful" (Pajares, 1992, p. 327).

This is the reason for the multiple methods selected in this research, as well as the multiple artifacts. All have been carefully selected on the basis of providing data that pertain to the components of beliefs, as well as the components of beliefs within attitude organizations. They are conceptualized to provide a rich source of data to better inform the inferences of beliefs, and change in beliefs that this research seeks. Better inferences are made by contrasting the individual (foundational) beliefs, with their belief structure. The belief structure contains foundational beliefs composed of data from individual participants regarding what they think, say, and do (Pajares, 1992).

MIXED METHODS DESIGN

Justification for Mixed Methods Design

With any interpretivistic study, the focus of this research is on the individual, with "…a focus on exploring how human beings make sense of experience and transform experience into consciousness, both individually and as shared meaning" (Patton, 2002, p. 104). A foundational question that interpretive research seeks to answer is "What is the meaning, structure, and essence of the lived experience of this phenomenon for this person or group of people?" (Patton, 2002, p. 104) Subsumed within this question, as subsets, are the two research questions of this research, which ultimately seek to investigate the impact of Japanese Lesson Study on the development of pre-service teacher beliefs, concerns, and understanding of a constructivist-learning environment.

Since the underlying assumptions of this research are beliefs are deeply personal, rooted in experience, with change accomplished by individuals, and an idiosyncratic experience, various instruments must be used to provide data to understand the foundational beliefs held by participants, as well as resolve change, instruments have been selected to reflect Frank Pajares (Pajares, 1992) call for research in which he argues

> "… that the investigation of teachers' beliefs is a necessary and valuable avenue of educational inquiry…" because research "…findings suggest a strong relationship between teachers' educational beliefs and their planning, instructional decisions, and classroom practices, although neither the nature of educational belief acquisition nor the link to student outcomes has yet been explored carefully" (Pajares, 1992, p. 326).

Indeed, Pajares continues:

> "I have also suggested that methodology and design of studies, as well as the measurement of educational beliefs, need careful reconsideration and researchers need agreement on the meaning and conceptualization of belief. Because they are specific enough to be reasonably operationalized and more easily measured, belief

> subconstructs, such as self-efficacy, lend themselves more readily to educational research" (Pajares, 1992, p. 326).
>
> "…because they [beliefs] offer a limited glimpse into a much broader system and because understanding their connections and centrality is essential to understanding the nature of their effect, researchers must study the context-specific effects of beliefs in terms of these connections. Seeing educational beliefs as detached from and unconnected to a broader belief system, for example, is ill advised and probably unproductive" (p. 326).

This can be summarized by the components of beliefs, as defined by Milton Rokeach. To be specific, each literature base informs an aspect or component from Milton Rokeach's definitions of beliefs.

This "call for research" directly informs the research agenda from which this research is derived. The purpose of this study is to investigate existing beliefs and images of teaching held by preservice teachers, through the use of the Japanese Lesson Study protocol. This study was conducted throughout a fifteen week, field-based elementary science methods course within a bilingual education program.

Data for a single participant's interview were coded and categories developed through the use of open coding (Strauss & Corbin, 1998) techniques. Axial coding (Strauss & Corbin, 1998) continued as additional data were added, ultimately with categories or phenomena refined through selective coding. Using the same process, additional cases were developed and cross-case comparisons. In addition, as discussed by Anfara, Brown, and Mangione (2002), methods were employed to ensure the credibility, transferability, dependability, and confirmability of findings. In their discussion of three exceptional dissertations, Anfara, Brown, and Mangione address strategies that can be employed "…to offer suggestions for assessing and publicly disclosing the methodological rigor and analytical defensibility of qualitative research." (2002, p. 28)

To further describe the method in detail, data from an initial case were analyzed and coded. Miles and Huberman define this as: To review a set of field notes, transcribed or synthesized, and to dissect them meaningfully, while keeping the relations between the parts intact, is… analysis (Miles & Huberman, 1994, p. 56). They continue, "…analysis involves how you differentiate and combine the data you have retrieved and the reflections you make about this information" (Miles & Huberman, 1994, p. 56).

This is consistent with Strauss and Corbin's Open, and Axial coding. The codes and their properties that were generated in step one were then related to subcategories in step two. Steps three and four involve delimiting and writing the theory, which in this study consist of phenomena, respectively. Throughout the process of generating and integrating codes, data is constantly revisited and reviewed until "…all the incidents can be readily classified, categories are "saturated," and sufficient numbers of "regularities" emerge" (Miles & Huberman, 1994, p. 62).

Justification for Embeded Single Case Design

The larger study is designed as an embedded, single-case design as described by Yin (Yin, 2003, p. 40) as the field-based, classroom setting dictates this framework. The unit of analysis is the elementary science methods class (as a whole) to address the case (Θ = Japanese Lesson Study), with multiple sub-units of analysis (individual participants). This research report consists of three participants selected from two groups of students selected from within the class as a whole (which comprise the elementary science methods course). The single-case design of the larger study allows for individual case development and cross-case analysis, ultimately relating to, and informing the main unit of analysis (whole class), which reflects the case (Lesson Study). This paper consists of a subset of participants from the main study; thus, each participant is a unit of analysis.

Description of Design: Concurrent Triangulation Design for Convergence

The design for this study is of mixed methods. The mixed methods concurrent triangulation design consists of one phase in which both qualitative and quantitative data being collected concurrently (Creswell, 2007; Leech & Onwuegbuzie, 2005; A. Onwuegbuzie & Teddlie, 2003). During this single phase, the fifteen-week course was divided into three sections (Figure 3.2), in order to achieve appropriate data collection to address the research question. The three sections designed to discern changes that occurred during the instruction portion of the methods course, and change occurring that corresponds to Lesson Study episodes. The unequal sections are: Baseline, Pre-Lesson Study, and Post-Lesson Study. For each section, qualitative data were collected and transcribed, with visual representations constructed from each interview. The text of each interview was also coded into five categories with the use of Interview Maps (J. Luft & Roehrig, 2005; Roehrig & Luft, 2006). After categorization the text was arranged into visual representations in a manner similar to concept mapping (Novak, 1990), according to the procedure outlined by Fellows (1994). Concurrent with the qualitative data collection, quantitative (Likert-scale) survey data were collected, and reduced using descriptive statistics represented with box and whisker plots and line graphs, analyzed apart from the qualitative data. The two phases were mixed with equal weightings during the interpretation stage in order to triangulate participant beliefs statements (address researcher bias, social guarding, and other pressures), and subsequent inference of beliefs of each participant. The rationale for this approach is that qualitative and quantitative techniques provide complementary data to triangulate participant beliefs from written reflections, verbal statements, class artifacts, and actions. These multiple sources and mixed methods provide robust evidence (Pajares, 1992) and multiple perspectives (Tyson

et al., 1997) for making and triangulating belief inferences and addressing researcher bias.

Figure 3.1: Triangulation Design for Convergence

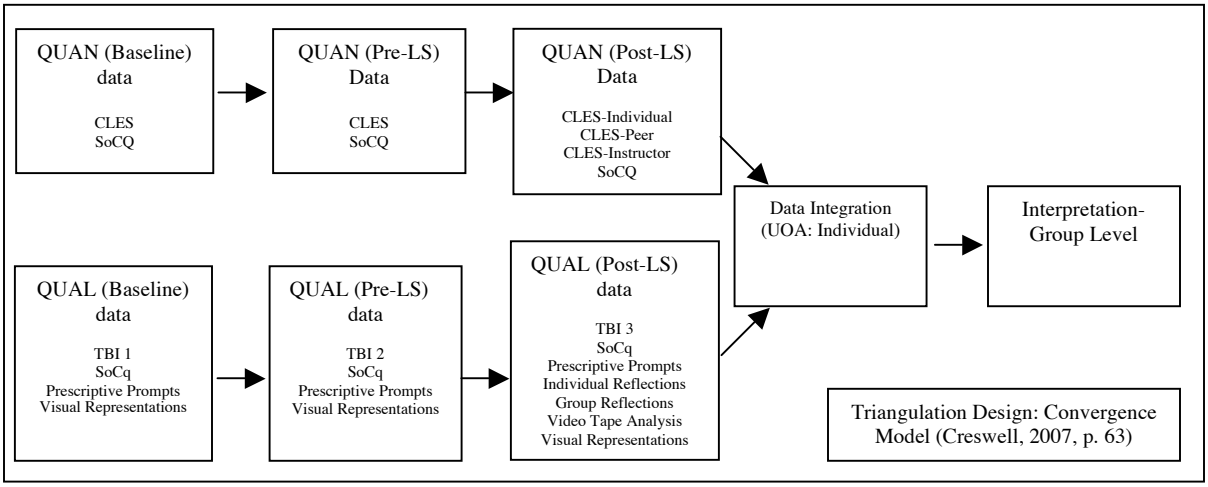


Figure 3.1: A representation of the baseline/pre-Lesson Study/post-Lesson Study design, the data collected during each time period, the point at which qualitative and quantitative data are integrated, and the discussion of the case as the final step after data integration.

OVERALL TIMELINE

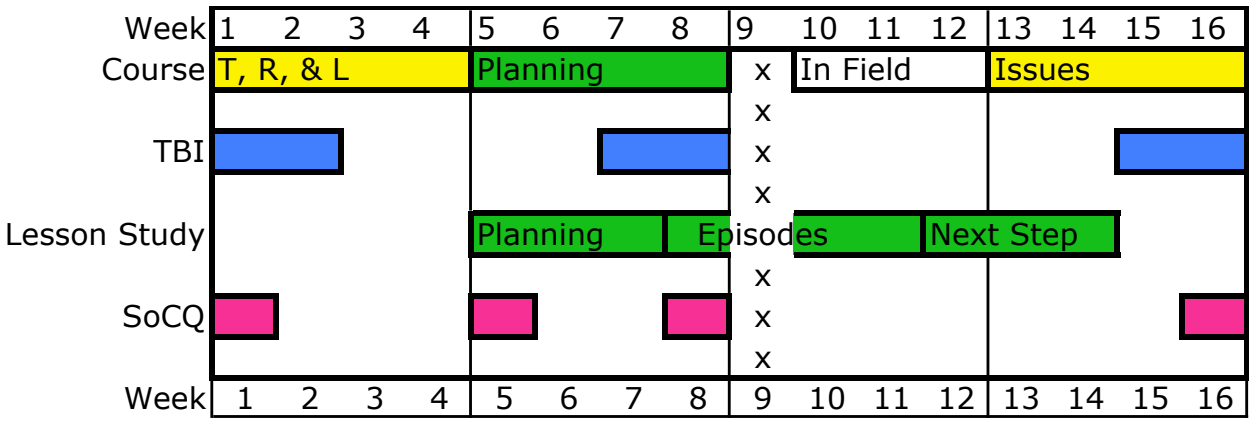


Figure 3.2: Overall Timeline for Study

Figure 3.2 depicts the eighteen-week, semester-length course with each meeting lasting at least three hours. After the sixteenth week, formal class meeting times have been completed, and there were about two weeks of final exams. The data collection is arranged into a baseline, pre-lesson study, post-lesson study design, with the divisions occurring between weeks 4 and 5, and weeks 7 and 8, with week 9 being a non-meeting week due to spring break. The major instruments used to capture critical pieces of data are shown with respect to the general course organization. Lesson study planning begins on week 5, as students begin to learn how to plan for inquiry lessons. The formal lesson study protocol begins on week 9 with the introduction of episodes, as described in chapter 2.

Figure 3.3: Timeline for Data collection

A complete listing of both the type of data collected and the week of collection (week number) are listed in the following diagram.

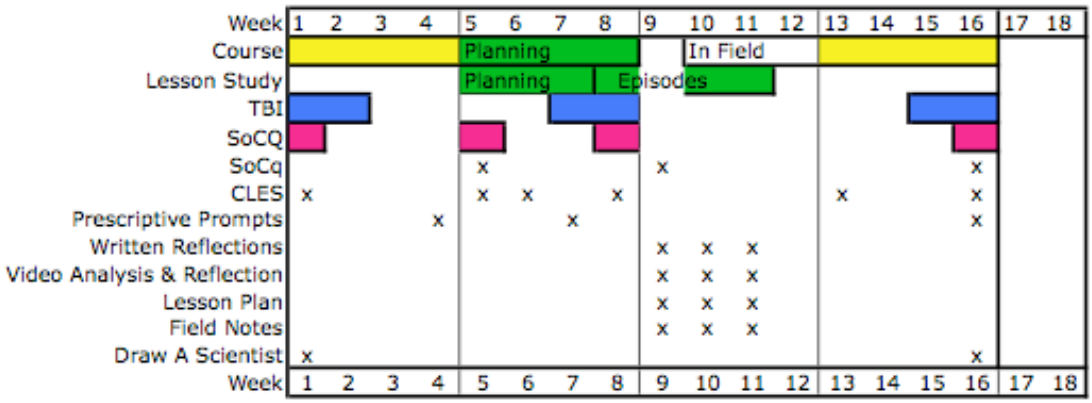


Figure 3.3: Various data sources, and the week in which they were collected. The reader will note that week 9 is spring break, and weeks 17 and 18 are final exam weeks, with no formal class scheduled.

GROUP SELECTION

Groups were created based on the field placements of students in local schools, with the three students purposefully selected on the basis that they were the first groups to teach, and also selected for the nature of each case.

OVERALL DATA SUBMISSION AND COLLECTION TIMES-BY PARTICIPANT

Figure 3.4: Submission and Collection Timeline for Major Assignments

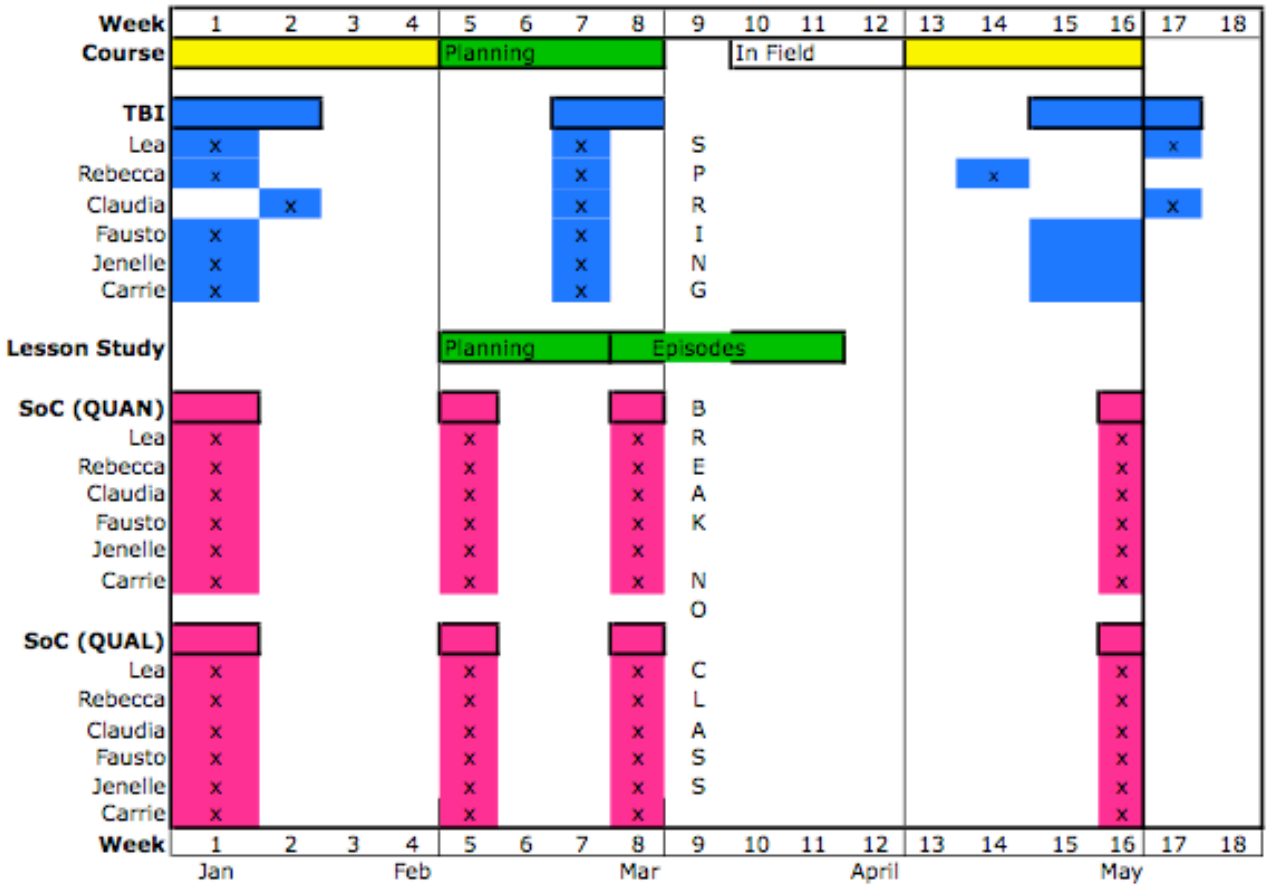


Figure 3.4: Throughout the semester, participants submitted assignments—some at the same time, others during differing weeks.

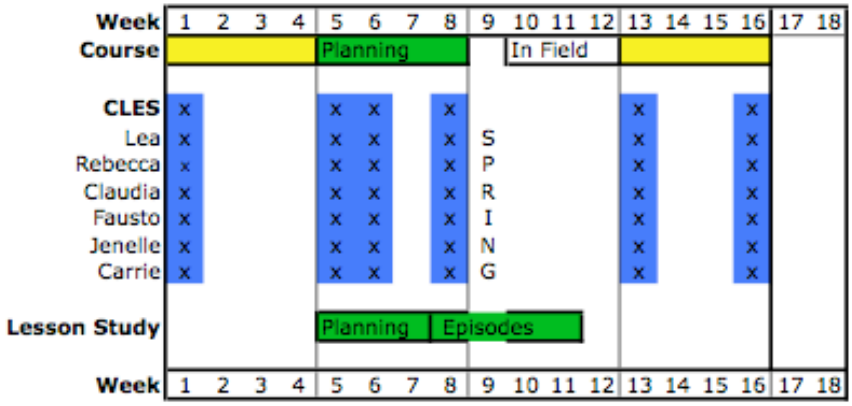


Figure 3.5: Data collection of the Constructivist Learning Environment Survey

Conceptual Framework for selection of methods-summary from chapter 1 & 2

Given the nature of this research, the need for triangulation of belief inferences, and the nature of beliefs, a case study of mixed methodology is required to make robust belief inferences, and construct participant beliefs in light of their prior knowledge. The methods course was split into time segments, as mentioned above, designed to discern between changes that occurred during the instruction portion of the methods course, and change occurring that corresponds to Lesson Study episodes. The sections are: Baseline, Pre-Lesson Study Episodes, and Post-Lesson Study. For each section, qualitative data are collected and transcribed, themes generated from each interview, and triangulated from multiple sources (Lincoln & Guba, 1985, p. 283), including reflections. The rationale for this approach is that qualitative and quantitative techniques provide complementary data to triangulate participant beliefs from written reflections, verbal statements, class artifacts, and actions. These multiple sources and mixed methods provide robust evidence (Pajares, 1992) and multiple perspectives for making and triangulating belief inferences and addressing researcher bias.

Conceptual Framework for Selection of Methods "The Matrix"

Table 3.2: Artifact and instrument match with belief (type) and component

	Types of Belief			Components of a Belief within an attitude organization			
	Descriptive	Evaluative	Prescriptive	Cognitive	Affective	Behavioral Intent	Actual (enacted) Behavior
SoC (Question number)				2,3,6,7,13,15 17,23,26,28,29 30,33,35	1,4,8,9,10,11 12,14,16,19,21 22,23,24,25 31,32,34	5,9,10,14 16,18,19,20 21,22,25,27 30,31,32,34	
TBI	1,2,6,8	4,5		3,7			
CLES 2(20)	1,2,3,4 5,6,7,8 17,18,19,20	9,10,11,12				13,14,15,16	
Field Notes	Yes	Yes	Yes				Yes
Lesson Plan	Yes	?	Yes	Yes	Yes	Yes	
Prescriptive Prompt	?	Yes	Yes	?			
Video of Lesson					Yes		Yes
Video of Group Discussion	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Reflection	P	P	P	P	P	P	P
Group Reflection	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	P=Possible	+=Probable	•=Actual				

Various methods and instruments were evaluated in two ways. First, by looking to see if the prompts contained within the instrument contributed data to any or all of the

belief components. For example, the SoCQ's Likert-scale responses were evaluated, and found to contribute to the Cognitive, Affective, and Behavioral Intent belief components, but not provide data requiring participants to reflect upon their actual teaching behaviors (with respect to their teaching plan behaviors), the situational nature of the context and environment that mediated their behaviors (context), nor does the SoCQ seek participant reflective thought as to the similarities and differences between their intended and actual behaviors. Therefore, other methods were sought to fill this "hole" in the data needed for a profile; hence, the use of Lesson Study, as well as the protocol that facilitates and guides student reflection on their intended and actual behaviors. The TBI requires participants to describe and evaluate teaching behaviors and intentions, but not advocate for any future action in the classroom. Thus, "prescriptive prompts" were developed to complete the "prescriptive belief" row's intersection with the various belief components.

A second evaluation criterion was, a contribution of data that contributed inferences about belief constructs about teaching elementary science, and student learning in science classrooms. A complete listing of the question matching, and data requirements may be found in the above Conceptual Framework (Table 3.2).

Methods were selected for their contribution to the columns of the matrix, mentioned in Table 2.1 and 3.2, above.

Methods (column vs row) section by section

Table 3.3: Artifact matching with belief components

	Belief Types			Belief components within attitude organizations		
	Descriptive	Evaluative	Prescriptive	Cognitive	Affective	Behavioral
SoC				•	•	•
TBI	•	•		•		
CLES 2(20)	•	•				•
Prescriptive Prompts			•			
FN	+	+	+			•
Lesson Plan	+	+	+			•
Video of Lesson	+	+	+			•
Video of Discussion	P	P	P	P	P	P
IR	P	P	P	P	P	P
GR	P	P	P	P	P	P
Key	P=Possible	+=Probable	•=Actual			

Alternatively, the methods and data sources may be conceptualized in the following figures, with other artifacts providing additional data for consideration.

Table 3.3 depicts the proposed instruments and artifacts, as matched to the various belief components. The questions from each instrument have been evaluated, and matched to a specific belief component or components, and can be found in Table 3.2, and Figures 3.6 and 3.7 (below) have an overview of the instrument questions and the matching of each question to a belief component. Each instrument will be discussed in turn, later in this chapter; however, the various methods of data collection each provide a rich source of data from which pre-service teacher beliefs may be inferred.

Methods were selected on the basis that they provide data that pertained to each one of Rokeach's belief components, and beliefs within attitude organizations, and the matching of each question, prompt, and source of data can be found in the following Figures.

Figure 3.6 and 3.7: Visual representation of component and instrument match

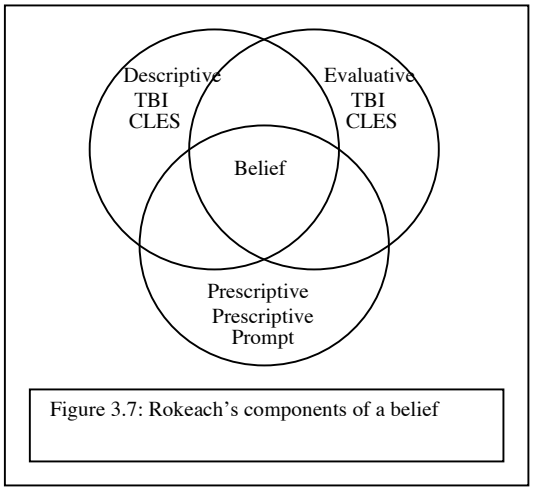


Figure 3.7: Rokeach's components of a belief

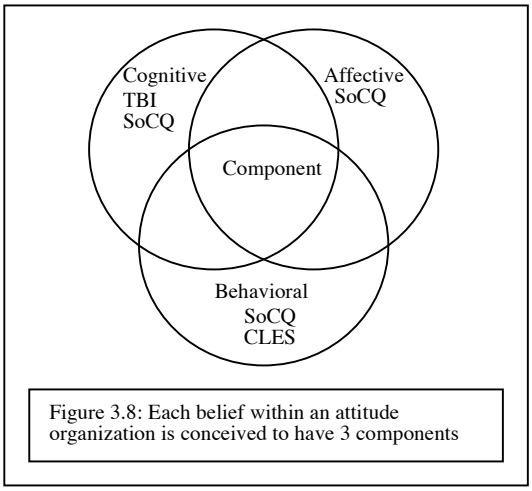


Figure 3.8: Each belief within an attitude organization is conceived to have 3 components

Quality of Research Design

Yin (2003), discussing the quality of various research designs, presents four tests for establishing the quality of a research project. They can be found in the following table (Yin, 2003, p. 34):.

Table 3.4: Case study tactics for four design tests (Yin, 2003, p. 34)

Tests	Case Study Tactic	Phase of research in which tactic occurs
Construct validity-establishing correct operational measures for the concepts being studied (p. 34)	Use multiple sources of evidence Establish chain of evidence Have key informants review draft case study report	Data collection Data collection Composition

Internal validity-(Not for descriptive or exploratory studies)-establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships (p. 34)	Do pattern-matching Do explanation-building Address rival explanations Use logic models	Data analysis Data analysis Data analysis Data analysis
External Validity-establishing the domain to which a study's findings can be generalized (p. 34)	Use theory in single-case studies Use replication logic in multiple-case studies	Research design Research design
Reliability-demonstrating that the operations of a study—such as the data collection procedures—can be repeated, with the same results (p. 34)	Use case study protocol Develop case study database	Data collection Data collection

Table 3.5: Table assessing research quality and rigor (Anfara et al., 2002)

Quantitative Term	Qualitative Term	Strategy Employed
Internal Validity	Credibility	Prolonged engagement in the field Use of peer debriefing Triangulation Member checks Time sampling
External Validity	Transferability	Provide thick description Purposive sampling
Reliability	Dependability	Create an audit trail Code-recode strategy (x3) Inter-rater agreement Triangulation Peer examination
Objectivity	Confirmability	Triangulation Practice reflexivity

Table 3.5 indicates the strategies employed in this research in order to assess Research Quality and Rigor (Anfara et al., 2002).

Table 3.6: Sources of evidence

Six sources of evidence (Yin, 2003, p. 100)	Construct of beliefs about teaching elementary science	Construct of beliefs about student learning in science classrooms
Documents and Artifacts		
DASTT	x	
Student Inventory-General	x	
Student Inventory-Science	x	
Video (self observation and reflection)	x	x
Archival Records		
Classroom Layout		
Student Demographics		
Class Demographics		
Open-ended Interview		
Informal conversations	x	x
Field notes	x	x
SoCq	x	x
Focus Interview		
Single participant interviews (TBI)	x	x
Group Debrief and Planning	x	x
Individual Reflection	x	x
Structured Interview and Surveys		
CLES	x	x
SoCQ	x	

Participant Observations		
Field observations	x	x
Video (Peer observation)	Provide multiple perspectives	Provide multiple perspectives
Physical artifacts		
Lesson Plans	x	
Written reflections	x	x

Validity

Since this research is a fully mixed, concurrent, equal status design (Leech & Onwuegbuzie, 2005, April 11-15, p. 11) for triangulation of belief inferences (Creswell, 2003), there are concerns with mixing quantitative methods (positivist paradigm) with qualitative methods embedded within an interpretivist framework and making belief inferences. Construct validity specifically pertains to the set of "operational measures" (Yin, 2003, p. 35) that are to be used to collect data, as well as based on an "integration of any evidence that bears on the interpretation or meaning" (Messick, 1989) of data. According to Samuel Messick, "validity is an integrated evaluative judgment of the degree to which empirical evidence and theoretical rationales support the *adequacy* and *appropriateness* of *inferences* and *actions* based on test scores or other modes of assessment" (Messick, 1989, p. 13, original emphasis). A major criticism of case study methodology is that operational measures have not been sufficiently developed, and that the researcher is using her/his "subjective judgments" (p. 35) to collect data. To ensure construct validity, and credibility for this research, two exploratory studies were performed. Please refer to the explanation of the exploratory studies, and sections in chapter 2. In short, first, the exploratory studies were performed to develop a theoretical framework used to identify and select methods that are consistent in collecting data specifically tuned to help the researcher make inferences about an individual's beliefs

about teaching. Second, the exploratory studies were performed to ensure that multiple perspectives were available when making the belief inferences. The multiple perspectives also help to identify and prevent bias interference in the current study.

To ensure that bias is identified and minimized, every stage of the data collection required participants to review their statements, and answer clarifying and probing questions provided by the researcher. The clarification questions gave the participant a voice in correcting mistakes and misperceptions by the researcher. For example, the Teacher Beliefs Interview was either completed via email, with clarification and probing questions returned via email exchange, or it was completed via a structured, formal/overt (Lincoln & Guba, 1985, p. 269) standard interview protocol in which follow up questions are formulated based on the participant's response to the formal interview question. In both the asymmetric (email) interview and the standard face-to-face interview, the formal questions and follow-up/probing question formulation are the same. In both cases, rapport had been established in that the researcher was present in the field and interacted with each participant every meeting.

DATA SOURCES

Being of mixed methodology, this research has significant qualitative and quantitative components. The qualitative component is designed to determine the "how" and "why" aspects of science teacher development. The data and findings will ultimately assist researchers and practitioners in the field of science teacher education through the use of case study analysis, with the development of emergent themes. The source data for this study were collected by the teacher/researcher, and triangulated from multiple qualitative sources (Anfara et al., 2002; Lincoln & Guba, 1985, p. 283), as suggested by Pajares (1992).

Quantitative Data Sources

The Constructivist Learning Environment Survey 2 (CLES 2(20))

Evolution of the CLES 2(20)

The CLES 2(20) (Johnson & McClure, 2004) began as a 42-item Likert scale instrument that was designed to give insights into the classroom learning environments of beginning science and mathematics teachers, by monitoring the development of constructive approaches to teaching science and mathematics (Taylor, Fraser, & Fisher, 1997, p. 293). Later, Taylor et al realized that various "cultural restraints" (p. 293) can interfere with the learning about, and understanding of, constructivist learning environments by beginning teachers. Therefore, the CLES was redesigned, and validated in Australia and The United States. Johnson and McClure (2004) furthered this work with 290 upper-elementary, middle, and high school science teachers, and pre-service teachers. Through the use of exploratory factor analysis, as well as internal consistency reliability analysis and the examination of each item in light of participants' questions and comments about each question, resulted in a revised, 20 question Likert-scale survey– the CLES 2(20).

Validation

The revised CLES was developed with 290 upper elementary, middle, and high school science teachers and preservice teachers, to be included within the context of a larger study of the classroom environments and teaching practices of beginning science teachers. Data gathered from the CLES were compared with data gathered from classroom observations and interviews with some of the participating teachers. Johnson and McClure used several techniques to develop and validate the revised CLES, and check for reliability. They used quantitative techniques for validation, such as exploratory

factor analysis, and internal consistency reliability analysis, and included written and interview data from each item and participants' questions and comments about various items to indicate confusion as well as give insight into participant thinking. All this led to a shortened revised version of the first CLES 1(30). Changes included keeping the original scales but reducing the number of items in each section. Too, questions were renumbered to group like questions in each section. The CLES consists of five sections. The five sections (consisting of four questions each) are defined and labeled as: Learning About the World (Personal Relevance); Learning about Science (Uncertainty); Learning to Speak Out (Critical Voice); Learning to Learn (Shared Control); Learning to Communicate (Student Negotiation) (Johnson & McClure, 2004). Each section contributes data for interpretation, and integration into a teaching profile. Specifically, the CLES 2(20) contributes to the overall building of a classroom profile for each teacher, contributing teacher and student perceptions of specific constructs within a constructivist learning environment. Information from the three constructs contributed to a teacher's teaching profile are knowledge of content, knowledge of students, and knowledge of pedagogy (Johnson & McClure, 2004, p. 73).

Data from two scales contribute to each construct. For example, Personal Relevance ("extent to which school science/mathematics is relevant to students' everyday, out-of-school experiences" (p. 68)) is combined with the Uncertainty scale (the "extent to which opportunities are provided for students to experience that scientific/mathematical knowledge is evolving and culturally and socially determined" (p. 68)) to provide information regarding the teacher's (preservice teacher's) knowledge of content. The second construct, Knowledge of Student, is constructed from information provided by the Critical Voice scale ("extent to which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods" (p. 68), and the

Student Negotiation scale ("extent to which students share with the teacher control for the design and management of learning activities, assessment criteria, and social norms of the classroom" (p. 68).

The third construct, Knowledge of Pedagogy, is constructed from information based upon the Student Negotiation scale and the Shared Control scale, which is the "extent to which students have opportunities to explain and justify their ideas, and to test the viability of their own and other students' ideas" (p. 73). Each of the above constructs contributes insights from the teacher's perceptions of the classroom environment, and the students (and their interactions) within the environment, as well as the perception of students within that environment. In the case of this research, the elementary students did not complete the survey, the peer group members and university instructor provided the alternative perspectives (student-participant perspective).

Justification and use of CLES within the context of this study

The CLES 2(20) (Johnson & McClure, 2004) is being used in this research to provide access to preservice teacher, university instructor, and student/peer perceptions of the classroom environment when preservice teachers taught lessons in authentic contexts. Perceptions of constructivist learning environments of the instructor/researcher, PST-teacher (PST-t), and PST-observers (PST-o) were gathered using the Teacher Form and the Student Form of the CLES 2(20), and used to provide information that contributes to the belief profiles of each preservice teacher. In light of the specialized use of Lesson Study, and the fact that Classroom Teachers were not trained in using Lesson Study, Classroom teacher (CT) responses were not collected, as CT's had not collectively negotiated understanding of CLES items and the relationship of meaning to constructivist learning environments with the participants, and instructor/researcher. The use of CT

responses would be problematic due to alternative conceptions of constructivist learning environments.

The CLES was selected with the following knowledge: it has been revised to reflect a critical theory perspective, the survey had been through rigorous reliability and validity checks to analyze the relationships between items, and the internal consistency of the CLES as a (Taylor et al, 1997). Most importantly, the CLES was selected to provide multiple perspectives of an abstract concept from multiple perspectives. Johnson and McClure state:

> While observations of classroom teaching and learning and interviews with classroom teachers can provide valuable insights into the classroom learning environment, they do not tell the whole story. As Barry Fraser explains (Fraser, 2001), student perceptions of the classroom learning environment are important, should be of interest to classroom teachers, and can be fairly easily measured with classroom environment perception instruments (Johnson & McClure, 2004, p. 67)

The CLES was used to gain insights into how preservice teachers are constructing knowledge of constructive learning environments, as well as provide additional perceptions and perspectives of individual preservice teachers-as provided by peers. (JLS protocol requirement.)

Administration of CLES 2(20)

Due to the iterative nature of Lesson Study, the CLES 2(20) was administered once after each teaching episode (Figure 3.3). Based upon a three-participant Lesson Study group, the scoring will occur with each observer or participant completing the 20-question survey. The result was a comparison of means that compares each participant or observer in order to gain insight into the perceptions of the preservice teacher and observers. The comparison of means will take place according to Johnson and McClure (2004), and result in the comparison of the pre-service teacher's score on the CLES

2(20), versus his/her two peers (who have observed the lesson and collected field notes), and the outside expert's score (the instructor of the course).

Traditionally, the CLES 2(20) is used to rate the teacher's view of the Constructivist Learning Environment vs. the students in the classroom. Because of situational constraints it is not possible to have elementary students complete the CLES 2(20); however, it is possible to have observers, the preservice teacher (who taught the lesson), and the outside expert rate the lesson using the Constructivist Learning Environment Survey. The resulting means from each section of the CLES 2(20) was compared, and reported in a manner similar to Figures 4.1 and 4.2, below.

It must be noted that since there are five sections on each CLES 2(20), this resulted in numerous graphical representations and comparisons; However, the numerous graphical representations and comparisons are necessary to ensure that an analysis is conducted to address Θ = Japanese Lesson Study, as well as sufficiently address the individual issues/research questions to the extent and depth needed.

There is also a component in which the instructor/researcher's Elementary Science Methods course needs to be evaluated. Taylor et al, and Johnson and McClure discussed the importance of comparison of instructor and students within the context of individual classes-important to note whether discrepancies exist due to differing perspectives. The course is designed and enacted from an interpretivist framework, thus the importance of comparison of instructor/researcher's self-report views of a Constructivist Learning Environment with that of preservice teachers. The data that this provides will give insights into the nature of the course that is enacted as well as insight into the "instructor as researcher" aspects of credibility/bias.

DATA COLLECTION TIME AND REQUIREMENT OF COLLECTION RELATED TO JLS

The CLES 2(20) was used to characterize the university instructor's views of constructivist learning environments with preservice teacher views periodically throughout the semester. The CLES 2(20) (Johnson & McClure, 2004) was collected at various times throughout the semester, as noted in Figure 3.3. In addition, the CLES was completed immediately after Phase 2 of each Lesson Study Episode.

Stages of Concern Questionnaire

Background

This is a quantitative, 35-question Likert scale survey designed to profile the beliefs of an individual about an innovation has been selected to provide insight into the concerns held by preservice teachers. The Stages of Concern questionnaire may be traced back to Francis Fuller's research on the "concerns" of teachers in the 1960's. These studies resulted in her (1969) work which proposed a developmental conceptualization of the "concerns of teachers," (1969) with three phases of concern: Pre-Teaching, Early Teaching, and Late Concerns. "These were abstracted to 'self,' 'task,' and 'impact' concerns with the 'impact' concerns being sub-divided into several levels." (Hall, George, & Rutherford, 1998, p. 3) Later, Hall, George, and Rutherford noticed similarities from their research, and the "Stages of Concern" instrument was developed, and validated (George, 1978; Hall et al., 1998). The theory relates that a reduction in one stage of concern with the corresponding increase in a different stage of concern indicates the potential shift in interest of the individual. This shift indicates a potential readiness to focus on new information. The Stages of Concern are: Awareness; Informational; Personal; Management; Consequence; Collaboration; Refocusing. Considered together, these give a concerns profile that contributes to the understanding of an individual

preservice teacher's belief structure, and the connections made between beliefs-the *structure* of the belief system.

Stages of Concern Survey-Likert Scale (SoCQ)

Fortney and Barufaldi (2008) seek to merge information from the Stages of Concern survey (pertaining to the affective belief component) with interview data (cognitive belief component), in order to provide specific information for teacher educators. The data allow Teacher Educators to operationalize findings within the context of their courses. Specifically, teacher educators need to know what beliefs preservice teachers bring with them into teacher education programs in order to plan appropriate experiences and lessons to facilitate reflection on existing beliefs in light of new information, and to create a space in which change may occur.

Analysis of Stages of Concern – Open-ended Statements

The Open-ended Stages SoCq consists of a simple prompt: "When you think about teaching science in a constructivist manner, what are your concerns?" (Newlove & Hall, 1976, 1998) and blank space for students to write in their concerns. Hall and Hord did not conceive this as a research instrument; however, its use provides an alternate set of data for triangulation of preservice teacher concerns.

Qualitative Data

Qualitative data include, individual, written, reflections, Group, written, reflections, Individual Statements of Concern—open-ended, and Likert-scale, statements of concern collected from individual students at multiple points during the semester. Since the statements of concern are primarily designed to elicit pre-service teacher concerns related to teaching science in a constructivist manner at the elementary level,

individual, open-ended statements were collected periodically during the lesson study episode, as well as at the beginning, middle, and end of the semester.

Video/Audio-tape (transcription) of group meetings – containing verbal statements of concern, and concern resolution, and discussion of potential solutions to concerns.

Teacher Beliefs Inventory (Roehrig & Luft, 2006) – 8 questions given at three times during the semester, with clarification questions submitted via email.

Field Notes – participants, participant observers, and observers will gather field notes during Phase Two (The Research Lesson) of the Lesson Study Episode, and use these for reflection and discussion during the Lesson Discussion Phase.

Prescriptive Prompts – Questions from the TeXES (Texas Educational Agency (TEA), 2006) state-mandated, teacher certification exam. Examples may be found in Appendix C.

Participant Semi-Structured Interview: Teacher Beliefs Inventory (TBI)

The TBI is a formal, semi-structured interview. Each participant was formally interviewed with a semi-structured protocol that consisted of eight questions from the Teacher Beliefs Inventory (Luft & Roehrig, 2005, April). Each question was followed up with additional questions that probed the interviewee's understanding of the nature and content of each answer. Each interview was recorded and transcribed by the researcher, and lasted 30-90 minutes. Each interview began with directions and conversation regarding the course, and participant experiences in their field placements and university courses. This ensured that each participant: 1) understood the nature of the interview, 2) its relation to the course, and 3) became as comfortable with the tape recorder as possible.

The follow up and clarifying questions were grounded in observations of each participant, and their understandings of the beliefs about teaching and learning; thus, tailored to each individual participant.

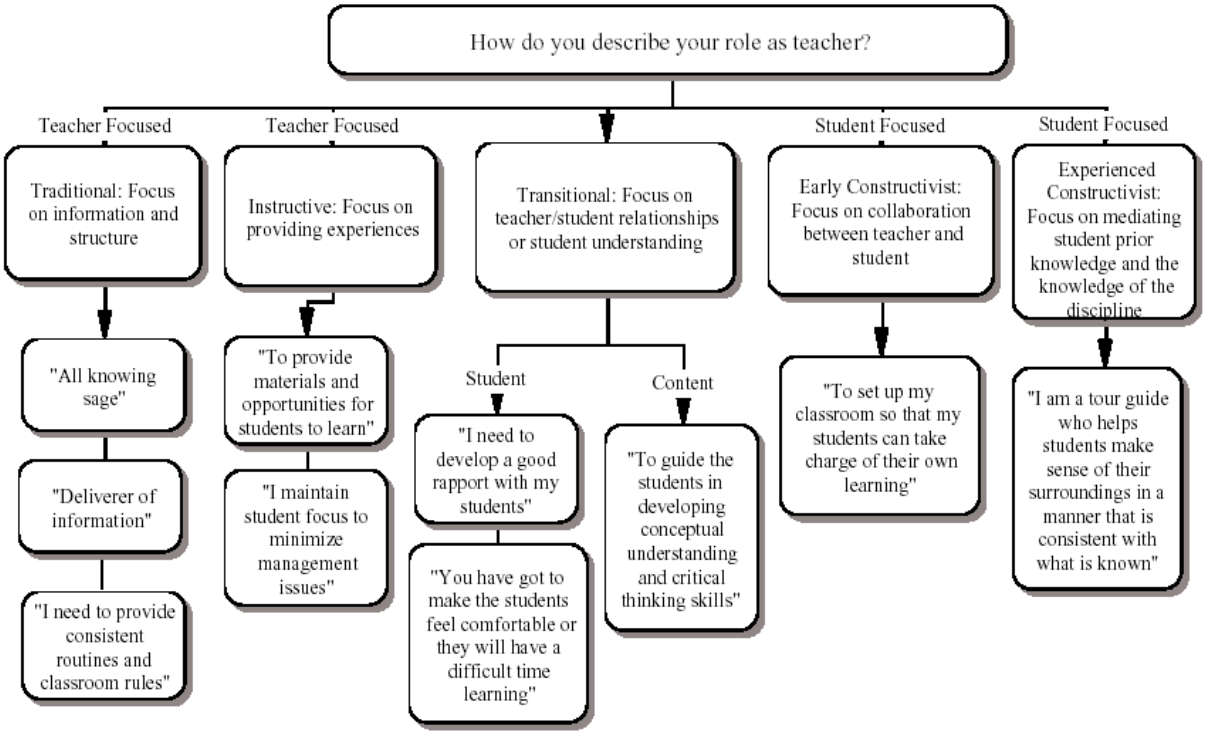
Formal, semi-structured, written interview (TBI)

Often, participants preferred to answer the questions in writing via asynchronous electronic techniques, due to time constraints. In these cases, answers were submitted in electronic form, and clarification or follow up questions were prepared, and sent via email with answers returned on the same document.

Background

The TBI evolved from SALISH I study (Yager et al, 1997), and was developed in an iterative manner with the categories and coding schemes, termed Informational Maps (J. A. Luft, Roehrig, & Brooks, 2004), and verified by experts in the field at each step in the development process.

Figure 3.8: An Informational Map



The resulting Teacher Beliefs Profile (J. Luft & Roehrig, 2005) will contribute to both constructs: beliefs about teaching, and beliefs about student learning.

Audio Tape and Video Tape Transcripts

Audiotapes of each group discussion, interview, and teaching episode were transcribed by the researcher. Videotapes of classroom observations were transcribed for the purpose of providing additional artifact data for use in the multiple data sources required for a robust source of data, and for use in triangulation of inferences and findings. Initial interviews began with a conversation to help participants get used to the tape recorder, as well as get used to the interviewer. In interviews two and three, this was not needed, as participants were used to the researcher, who was the instructor of the

course. Throughout the semester a rapport developed that was grounded in respect, and an understanding that there were no stupid statements, and any statements were subject to revision. None were grade-based, which was made explicitly clear, often repeated at the beginning of every interview. Due to the many interviews in such a close time period, participants preferred asynchronous interviews by way of email, with clarifying questions asked as "follow up" questions. In some cases, participants did not respond to clarifying questions, but supplemented their statements during reflective moments.

Participant observations were a requirement of the Lesson Study protocol, with the researcher, and all participants in the group in attendance. Per Lesson Study protocol, data were gathered that specifically pertained to the goals of the lesson, and student learning, responses, and questions. Participants learned several field note-taking techniques, and practiced selecting the appropriate technique for the "observation." Examples of, techniques include the use of a map as a technique for teacher use of classroom, student questioning/participation, or to keep track of equity in the classroom. Dialogue or bullet point notation was used to keep track of specific questions (to assess open-ended or higher order question use), and time coding notation was used to evaluate ideas as wait time or time management, as chosen by individual choice.

Data from multiple sources (including participant observation) have been gathered to triangulate inferences about preservice teacher beliefs. These inferences are then brought up during bi-monthly interviews in an attempt to determine how well a particular belief inference is indicative of the preservice teacher's stated belief. For example, first level member checking involved discussing collected data and inferences with participants to ensure that the researcher has accurately transcribed interviews, captured or understood the essence of intended teaching behaviors versus actual behaviors, and understood belief statements made by participants. Data were sampled

over a 15-week semester, and comprised into three unequal time periods. The unequal time periods were set to encompass Japanese Lesson Study protocols and time frame, as well as avoid state-mandated, high-stakes testing and preparation in the public, elementary, school. During the semester, participants were consistently observed via participant and peer observation, questioned, and engaged in discussion and reflection during regular class sessions, as well as interviewed and observed outside of regularly scheduled class meetings in group and individual settings. It was within the group and individual settings that member-checks and clarification interviews occurred. Data were interpreted weekly for the purposes of planning for instruction. Classes met once a week for 3 hours over the course of a 15-week semester, with approximately 10-15 additional hours (per student) of observation, meeting, and interview times scheduled outside of class over the semester. Findings and interpretations have been submitted for peer debriefing and external audits. (Brantlinger, 2005)

Inter-rater Agreement

All Teacher Beliefs Interviews were transcribed by the author, and analyzed by a second coder with extensive experience coding interviews using Informational Maps (J. Luft & Roehrig, 2005; Roehrig & Luft, 2006). Both coders agreed 98% of the time, down to the sub-category (See Appendix B). For example, the TBI may be generally broken down into three general categories: Teacher-focused, Transitional, and Student-focused. Sub-categories are as follow. Teacher-focused sub-categories are broken down into Traditional and Instructive, Transitional is categorized into a sub-category by the same name, and Student-focused is further divided into sub-categories of Early Constructivist and Experienced Constructivist. Agreement was obtained to 100% in general categories, with greater than 95% agreement in sub-categories, for each participant in this study.

While inter-rater agreement was ongoing, the second rater made notes about most of the categories generated from open coding, furthering the trustworthiness of the interview analysis.

Disagreements that presented during the inter-rater agreement coding process primarily revolved around decisions of placement of emphasis on either initial "stock" answers, or participant answers to clarifying questions. Specifically, difficulties arouse due to the nature of examples given by participants. In the examples given, if science content knowledge was weak, this tended to make examples vague, and difficult to code; however, eventually through discussions, an agreement was reached on categorization within the context of the Informational Maps and categorical descriptions. (See figure F 3.8)

Video Tape Coding with The Reformed Teaching Observation Protocol (RTOP)

Videotaped teaching episodes were coded with the RTOP, in order to provide evidence to compare and contrast with self-report data, and student (and group) reflections. Because the lessons are collaboratively planned with specific goals, there is a limited use for the data. It is the belief of the researcher that these data will provide contextual information from which additional questions and concerns may be gleaned. As Pajares indicates:

> …if reasonable inferences about beliefs require assessments of what individuals say, intend, and do, then teachers' verbal expressions, predispositions to action, and teaching behaviors must all be included in assessments of beliefs. Not to do so calls into question the validity of the findings and the value of the study. Traditional belief inventories provide limited information with which to make inferences, and it is at this step in the measurement process that understanding the context-specific nature of beliefs becomes critical (1992, p. 327).

Prescriptive Prompts: TEXES Questions

A measure that has been employed in order to obtain data and insights into the "prescriptive" component of beliefs was administered periodically throughout the semester. The measure consisted of one, or in some instances, two questions from the TEXES teacher certification test from the state of Texas presented at three different times throughout the semester. This is a multiple choice answer question about what the preservice teacher would do in a given situation. This situation was spelled out in the paragraph before the question was asked. This was followed up with a written justification of why the preservice teacher chose that answer. This measure was then compared and contrasted with other data collected, ultimately producing a more robust source of data.

Two example questions from the Bilingual Education Supplemental Materials (102) (Texas Educational Agency (TEA), 2006) may be found in Appendix C.

Additional Artifacts

In addition to the aforementioned instruments and measures, additional artifacts were gathered that provided additional insight into the different belief components, as to make informed inferences that contain the context, and views of the preservice teachers regarding the contexts within which they taught their lesson. These additional artifacts were: lesson plans, observations of the outside expert, mentor teacher, and peers, as well as field notes that form the basis of preservice teacher reflections on each lesson. Field notes, as required by Japanese Lesson Study protocols, are specifically guided by goals. The goals were developed by the group, with the individual preservice teacher who taught each episode, therefore acting to focus attention on individual concerns, and allow preservice teachers to begin to take charge of their learning.

CONTEXT OF STUDY

This study was situated within a one-semester elementary science methods course situated within an 18 course-hour professional development sequence (PDS), in which the researcher was the instructor of the course.[4] Preservice teachers either take the course in their first semester of the PDS (Intern I semester) or in their second semester (Intern II semester) of the PDS. The third semester is the student teaching semester. Preservice teachers enter into the program during their third year—most as traditional Juniors. The PDS is designed as a field-based program that places preservice teachers into classrooms for 1.5 days out of each week in urban elementary schools. It is within these Intern environments that preservice teachers reflect upon and seek to put into practice what is taught in their university coursework. Within the context of their university courses, preservice teachers are challenged to make sense of the experiences in their internship classes. preservice teachers generally have two cohorts combined into one university class-in other words classes which contain Intern I and II preservice teachers.

Description of the Elementary Science Methods Course

Two cohorts of students were enrolled in the Spring Semester of a bilingual, Elementary Science Methods course, which required fluency tests in Spanish and English for entry into the program. This was a normal progression in the undergraduate program at the university that culminated with an EC-4 bilingual certification. In all, 27 students enrolled – 11 from one cohort, 16 from the second. The 11 from the first cohort would student teach the next semester, with the remaining 16 the following semester. All were asked to volunteer to participate in the study; none were compensated in any way. This

[4] Work was an integral part of the course and graded on the bases that follow-up and clarification questions were required; however, no point values were assigned. This is consistent with the instructor's conceptualization for the course.

was the third year in which Lesson Study was enacted in this program, and the instructor of the course is also the researcher.

Being a field-based program, the two cohorts of preservice teachers met at a local, urban elementary school for three out of five days each week, with instructors rotating between the university, and the local school. The university students (herein called pre-service teachers) have their own classroom, and complete access to the local elementary school – often entering elementary classrooms for observation assignments, or to work with elementary students in authentic contexts. As an additional part of the field component or "internship," preservice teachers are assigned bilingual, elementary classrooms at an additional school for the other 1.5 days of the week. It is in these internship classrooms that preservice teachers are required to teach six lessons during the semester, with one being a science inquiry lesson.

SCIENCE METHODS COURSE ORIENTATION

The elementary science methods course was designed using Abell and Bryan's framework for reflection orientation (1997). When enacting a course designed around a reflection orientation framework, the responsibilities of the methods instructor are to elicit preservice teacher beliefs, concerns, and images of teaching, as well as "modeling beliefs, values and assumptions about science teaching and learning" (p. 153). Abell and Bryan further characterize this responsibility as "asking students to describe their ideas, beliefs, and values about science teaching and learning and by offering experiences that help them clarify, confront, and possibly change their personal theories" (p. 154). Abell and Bryan do this by weaving four "contexts for reflection" (p. 155) together throughout the semester: "Reflection on others' teaching via integrated media materials; Reflecting on [one's] own teaching via field experiences; Reflecting on self as science learner via science activities; and Reflecting on expert opinions in teaching via course readings" (p.

155). In this methods course, Japanese Lesson Study (C. C. Lewis, 2002) was selected as a major component to facilitate reflection on one's own personal experiences, beliefs, values, and concerns, (and teaching experience) as well as facilitate reflection on others' teaching experiences. In a short, Lesson Study encourages deep reflection.

DESCRIPTION OF LESSON STUDY AND ITS USE IN THE FIELD EXPERIENCE

Recall that the main pathway or framework to facilitate change in university student thinking about teaching and learning is called Lesson Study, described earlier. In short, preservice teacher participants in this study participate in collaborative planning, individual classroom teaching in authentic classrooms, individual and group reflection components, and group discussion/re-planning, and justification of changes in plans. In the case of elementary science teacher education, this entails a component in which pre-service teachers teach in authentic classrooms, and are afforded the time to reflect, discuss, and make the connections that are paramount for learning to be a classroom teacher.

PARTICIPANT SELECTION

This study proposes to select participants on the basis that potential pre-service teacher participants are enrolled in an elementary science methods course within a field-based teacher certification program which results in an EC-4 bilingual teaching certificate. Too, all pre-service teacher participants have completed all requirements for teacher certification, including both verbal and written proficiency exams in Spanish and English, and are currently enrolled in a Professional Development Sequence (PDS). All participants meet for their university course off-campus, at a local, urban, elementary school. Within the construct of the PDS, there is an additional internship requirement in which pre-service teacher participants are required to be in the field at a second urban,

elementary school for 1.5 school days. Participants for this study were selected on a voluntary basis, out of a total of twenty-six potential participants. Pseudonyms were used for all participants, their mentor teachers, and school names. Three were chosen for this report.

Groups

Each Lesson Study group was naturally organized within local schools according to individual field placements. Group organization, according to Lesson Study protocol, dictated that each participant within a group be available for meetings, planning, reflection, and observations.

Rationale for group selection

Individual cases have been selected on the basis of their contribution to the understanding of the phenomena being studied, as delineated by the research questions. All participants were undergraduates.

DATA COLLECTION

The CLES 2(20) was collected immediately after Phase 2 (of each Episode) has been completed, and consists of twenty Likert scale items rated individually by multiple participants. The Teacher Beliefs Inventory (TBI) consists of eight semi-structured interview questions, and was given at three times in the semester, and followed up with clarifying questions. Statements of Concern were gathered at multiple points during the semester, mainly corresponding with the iterative nature of the Lesson Study cycle, which will provide at least two data points. Additional data were derived from artifacts collected during the Planning and Revising Phase (Phase 1) of each Lesson Study Episode (Lesson Plans and Statements of Concern), while other data (Teaching Video/Audio Tape and Participant Field Notes) are gathered during Phase 2: The

Research Lesson (Teaching) Phase, while additional artifacts were collected during Phase 3: Lesson Discussion (Individual Reflections and Group Reflections).

DATA ANALYSIS

Data analysis was performed such that quantitative information is analyzed to do two things. First, the Likert-scale instruments were evaluated to construct the big picture, that is, the class as a whole. Issues such as general concerns profile of the class, and of each cohort were interpreted as to the general feel of the class. Specifically, judging by the concerns profiles, inferences about what the class as a whole chooses to focus their attention on with respect to the content of the course. Likert-scale instruments also contributed to an understanding of the negotiation of three constructs. The constructs are: knowledge of students, knowledge of content, and knowledge of pedagogy, as evidenced by the Constructivist Learning Environment Survey. Throughout the fifteen-weeks as participants are learning about constructivist pedagogy, or characteristics of constructivist classrooms, the profiles change as evidenced by the CLES survey. Using this picture as a backdrop, within which the individuals discussed in this research are negotiating meaning and planning lessons, the selected participants were viewed as they come to terms with their existing beliefs about teaching elementary science, and student learning in science classrooms. This big picture perspective serves to situate various discussions, and delineate the space that was their Elementary Science Methods course.

Second, open coding (Strauss & Corbin, 1998, p. 223) of Teacher Belief Interviews (Roehrig & Luft, 2006) was performed to develop themes and initial beliefs of participants. To this emerging picture additional data were added, such as individual responses to the Draw A Scientist activity (Farland & McComas, 2007), or individual responses to the prompt “draw a concept map showing what it means (to you) to teach science to young children.” Once this was complete, axial coding (Strauss & Corbin,

1998, p. 229) began, with pieces of the "data puzzle" (Strauss & Corbin, 1998, p. 229) fit together with the aid of several lenses and schemas to help construct individual belief structures, as described in chapter 1. Emerging beliefs were ordered according to their central or peripheral nature (psychological strength), whether the beliefs are formed from primary experiences, or derived from a source of authority (quasi-logical relationship between beliefs), or whether the beliefs are isolated (Cooney et al., 1998; Green, 1971; Milton Rokeach, 1968), or nested (L. A. Bryan, 2003) within the structure (held in clusters). Changes, on this basis will serve to answer the first research question.

Additional insights were gained by using Perry's (1999) model of intellectual development in conjunction with Belenky et al's model (1986) to understand individual sources of authority. Interestingly, the Stages of Concern instrument, Constructivist Learning Environment Survey, and the Teacher Beliefs Interview all connect with a point of reference, around a shift in authority. This shift indicates that the individual participant has internalized the authority, which is embodied in their outlook, and understanding of constructivist pedagogy, and constructivist classrooms. It is this shift that must occur in the preparation of science teachers, to better prepare our preservice teachers of today for teaching in politically charged atmospheres in tomorrow's technology and science-rich classrooms.

The three lenses that aided with the integration and interpretation of data in order to construct an understanding of how preservice teachers made sense of new instruction, and new experiences in authentic classrooms were discussed by Tyson et al. Tyson et al (1997), in their research on conceptual change, suggested a multidimensional framework for interpreting change events in classrooms. The three lenses were, an epistemological lens, an expectational lens, and a social/affective lens, which help provide different perspective for this research.

Once axial coding was completed, selective coding (Strauss & Corbin, 1998) was performed to fill in the holes, and to prepare for cross-case analysis of individual preservice teacher experiences, and their understanding of new information and new experiences in teaching elementary science.

Cross-case analysis was performed, and structured by the assumptions of the CBAM, as discussed above. Differences of understanding and sense-making between and amongst the preservice teacher groups as well as contributions to group understanding of teaching in a constructivist manner are discussed, with a new set of themes emerging.

USE OF MULTIPLE LENSES

One way to approach credibility threats (Anfara et al., 2002) is to use multiple lenses to interpret data (Tyson et al., 1997). Specifically, the three lenses that were utilized are an epistemological lens, an expectational lens, and a social affective lens. These three lenses are suggested by Tyson et al (1997), with each providing important insights. Specifically, the epistemological and expectational lenses provide insight into each individual's interpretive and analytic framework that they bring with them into each learning situation. These three lenses serve to bring different tools to bear in the search for understanding, and sense-making of participants.

Epistemological Lens

Epistemology is defined as "how students perceive their own knowledge" (Posner et al., 1982; Tyson et al., 1997, p. 400), the goal in using an epistemological lens is to provide insight into an individual's perception of her own knowledge, the strength with which that knowledge is held, and how secure the individual preservice teacher is in engaging with the subject. Thus, if initial epistemological commitments are known, an understanding of the likelihood of the individual finding instruction initially plausible or

implausible will help to provide an insight into how each preservice teacher interprets new information and instruction with respect to their initial beliefs, images of teaching, and prior knowledge. Posner et al discuss several ways by which new information may become plausible to an individual, thus, any one may be an entry ticket into a reflective stance on how new information relates to prior beliefs, knowledge and images of teaching. Of the many pathways that may be used by preservice teachers to make sense of new information, consistency is theorized to be important. Consistency of new information with initial conceptions, and plausibility of solutions to problems (p. 218) and are vitally important for teacher educators to understand, as new information perceived as being inconsistent with existing conceptions may serve as an avenue to spur deep thinking to solve the problem.

Expectational Lens

The expectational lens "examines the way each student "perceives the nature of the thing being studied" (Tyson et al., 1997, p. 398), which in the case of preservice teachers, examines the way they perceive the nature of the classroom, and the nature of the role of the teacher *in* the classroom. One method of evaluating data, and placing the data into ontological categories may be found with Chi et al (1994). Chi et al argue students "place objects and events into inappropriate categories" (p. 399). Chi explains that, ontologically speaking, each category has totally different ontological attributes, with no categories overlapping. It is when the object or event changes ontological categories that Chi indicates that learning results in a major reorganization of the existing framework. Simply changing the assignment of a certain idea or object to a different category indicates that a change in conception has occurred.

According to Chi, in order to assign categories, a "predicate table" (p. 39) is to be used. Predicate tables list phrases, categories, and words used by individuals that have

been organized into ontological categories. The specific categories that were used in this research are presented by Roehrig and Luft (2006). They presented 5 categories. Each category may be conceptualized as ranging from Teacher-Focused instruction to Student-Focused Instruction (J. Luft & Roehrig, 2005; Roehrig & Luft, 2006).

The first category which is exemplified by Teacher-Focused responses, is identified as "Traditional" (Fletcher, 2006, p. 66). Responses identified as traditional teaching is characterized by the teacher as the center of the instruction in the classroom. For example, in answer to the question "How do you describe your role as a teacher?" (J. Luft & Roehrig, 2005, p. 4), a preservice teacher may respond: "I am the deliverer of information, or I need to provide consistent routines and classroom rules" (J. Luft & Roehrig, 2005, p. 10). Specifically, students follow guidelines and procedures with a focus on the teacher providing and transmitting information (p. 10).

The second category which also is exemplified by Teacher-Focused responses, is identified as "Instructive" (Fletcher, 2006, p. 66). Using the same question as above, a preservice teacher may answer "I want to maintain student focus to minimize disruptions" (J. Luft & Roehrig, 2005, p. 10). The focus of the answer shifts from providing information and structure to providing experiences for students (J. Luft & Roehrig, 2005, p. 10).

The third category is neither Teacher-Focused nor Student-Focused. This third category is identified as "Transitional" (J. Luft & Roehrig, 2005, p. 10). The focus for the transitional category is squarely on "teacher/student relationships" (p. 10) with subjective justification of decisions or response based in the affective domain (p. 10). Responses such as "I need to develop a good rapport with my students, or [y]ou have got to make the students feel comfortable or they will have a difficult time learning, or [I will] guide

the students in developing conceptual understanding and critical thinking skills" (J. Luft & Roehrig, 2005, p. 10) are examples of this category.

The fourth category, the Early Constructivist category (exemplifying a shift in authority in which the preservice teacher begins to understand the subtle use of authority in classrooms), is the first category that includes collaboration between students (J. Luft & Roehrig, 2005, p. 10). This is the first that may be classified as Student-Focused, and may be exemplified by preservice teacher responses such as "[my role as a teacher is] to set up my classroom so that my students can take charge of their own learning" (J. Luft & Roehrig, 2005, p. 10).

Last, the fifth category, Experienced Constructivist, has the focus shift to "mediating student knowledge, or interactions" (J. Luft & Roehrig, 2005, p. 10) between students. Examples of preservice teacher responses include "I am a tour guide who helps students make sense of their surroundings in a manner that is consistent with what is known" (J. Luft & Roehrig, 2005, p. 10).

The reader will note that student responses are evaluated, and placed into one of the above five categories, the entire set of responses from each participant, along with additional data, provide insights into the preservice teacher's beliefs about teaching and student learning in the classroom. As Chi et al describe, changes in responses translate into changes in ontological category placement, thus indicating a change in student understanding. In our case, the change may, then, indicate a change in preservice teacher's beliefs, conceptions, or images of teaching.

Social/Affective Lens

The social/affective lens provides insights into the social and affective "conditions" needed for change (Pintrich et al., 1993, p. 168). Specifically, Pintrich,

Marx, and Boyle frame their argument for the use of a social/affective lens with a few issues. The pertinent ones follow.

Firstly, prior knowledge can "impede" (p. 191) learning if it is not "veridical" (p. 191). If new information does not coincide with prior knowledge, or a "strongly held set of beliefs" then a defensive stance may be taken by the preservice teacher to protect prior knowledge and existing set of beliefs, thus discarding or discrediting new information. This may result in the preservice teacher's choice to engage in instruction, or to "activate or transfer appropriate [prior] knowledge" (Pintrich et al., 1993, p. 168). Likewise, if prior knowledge is veridical, then the prior knowledge may enhance and encourage learning by providing a basis for understanding new information and a common language that facilitates engagement in new activities.

Secondly, the issue discussed by Pintrich et al (1993) is the issue that "learners are purposeful, while ecosystems are not" (p. 192). This issue specifically refers to the issue of conceptual ecology, commonly used in the conceptual change literature. Conceptual ecology refers to a natural progression that occurs in the resolution of points of dissatisfaction, or in the case of nature, dissatisfaction can be conceptualized as pressure, which drives resolution of the pressure (i.e. carrying capacity, or predator-prey relationship are natural, but not intentional). Conceptual ecology assumes that this progression naturally occurs. Pintrich et al argue that individuals, unlike ecosystems, purposefully select matters in which they are most dissatisfied with to specifically direct their attention and efforts. An individual's selection is based on some individual (quite possibly unrecognized) criteria. In the context of a university course where preservice teachers are learning to teach, there are many concerns, dissatisfactions, and pressures that divide an individual's attention; however, the construct of stages of concern is used to identify a preservice teacher's most intense concern, and assumes that until that intense

concern is resolved, it will be the main focus that preoccupies their attention. Other concerns that are not as intense will be placed on "hold" until the intense concerns are addressed, and resolved.

In the case of this research, the construct of personal concerns, and stages of concern are used as an indication of affect, with changes in concerns indicating a change in beliefs, images, or understanding of prior knowledge. In Pajares' idea, the concerns construct provides insight into an individual's intentions. Specifically, returning to Pajares' challenge for new research—new research must focus on what preservice teacher's "say, intend, and do" (p. 316). The concerns construct is used in this research to focus attention on, and engage preservice teachers in activity to resolve their most important concerns (Fuller, 1969; George et al., 2006a; G. Hall, 1976; G. E. Hall et al., 1998).

Lastly, the conditions necessary for learning to occur, "dissatisfaction, intelligibility, plausibility, and fruitfulness" (p. 192), as Pintrich et al argue, are not evaluated, selected, or decided upon without the use of "affective variables and value beliefs" (p. 192). Variables such as personal concerns, interest, efficacy, and comfort of each individual impact their decision of attention. Therefore, the social/affective lens is an important consideration in beliefs research that needs to be included.

In sum, use of three lenses to provide perspective and help resolve potential change in each preservice teacher's belief structure is important. The use of an epistemological lens provides insight into how individuals view their own knowledge, who or what they view as an authority, and whether they find new information intelligible, plausible, and fruitful. The use of an expectational lens provides insights into an individual's expectations of classrooms, student learning, and the role of the teacher in classrooms. This is their basis of comparison, upon which new information is evaluated,

or new information is engaged. The last lens, a social/affect lens, provides indicators as to what an individual is choosing to attend to, or the focus of their attention. Hence, the use of three lenses is an important factor for inferences on preservice teacher beliefs, and how they make sense of new information.

Chapter 4: Results

INTRODUCTION

In setting the stage of preservice teacher prior experiences, it is important to understand the background and experiences of each of the participants. Table 4.1 compares the background and experiences in science of each participant selected for this discussion.

Table 4.1: Comparison of background experiences

	Lea	**Rebecca**	**Claudia**	**Fausto**	**Jenelle**	**Carrie**
Year in PDS	Intern I	Intern II	Intern I	Intern II	Intern II	Intern II
Practice Lessons Taught in PDS	Zero	6	Zero	6	6	6
Experience with Innovation	Non-user	Non-user	Non-user	Non-user	Non-user	Non-user
Formal Teaching Experience	No	No	No	No	No	No
Observation experience	No	Yes	No	Yes	Yes	Yes
Informal Teaching Experience	Yes (Tutor)	Yes (Tutor & Classroom Helper)	Yes (Tutor)	Yes (Tutor)	Yes (Private Tutor, Classroom Aid, Sunday School Teacher)	Yes (Tutor, Intern Fall 2005)
Lesson Study Sequence	Group 1, Episode 1	Group 1, Episode 2	Group 1, Episode 3	Group 2, Episode 1	Group 2, Episode 2	Group 2, Episode 3

At the beginning of the semester, 26 preservice teachers were enrolled in the course. 16 students were in a cohort that was in their second semester of the professional development sequence. The other 10 were new to the PDS. Participants selected were composed of two intern I students, and 1 intern II student. They were selected from a subset that the researcher worked most closely with, due to scheduling. None had any formal teaching experience because all were uncertified. Most had prior informal

teaching experiences, but not all had positive experiences in science. (See for example, Carrie.) None of the preservice teachers had any experience with teaching science lessons in any other way than via traditional teacher-centered instruction. While intern II students did teach at least 6 lessons the previous semester, none were science. In fact, few students recalled observing science being taught in their previous semester's field placements.

Carrie indicates that she has had horrible experiences in science, however, her experience with her Lesson Study group indicates a shift from her previous experiences. Indeed, Carrie, along with her colleague and partner, Fausto, banded together to help and teach Jenelle, during the planning and revision stage of Jenelle's lesson.

Constructivist Learning Environment Survey (CLES 2(20))

The Constructivist Learning Environment Survey 2(20) has been previously discussed as a survey that has been revised to include a critical theory perspective, and validated on several continents. We now revisit this instrument to better understand how it will be used within the context of this research. It will be used to provide the university instructor and preservice teacher perceptions of classroom learning environments. On each subscale, participants select values on a Likert-scale that range from Almost Always (5), to Almost Never (1). Answers were coded such that comparisons (via boxplots) can be made between teacher perception of constructivist learning environments and preservice teacher perceptions of learning environments.

All participants, as a class, negotiated an understanding on the use of the CLES and its subscales as a tool to better understand and enhance perception of constructivist pedagogy. Multiple videotapes were viewed, and lessons enacted in which a teacher was teaching a lesson using a student-centered approach to instruction, with the instructor of the course guiding and facilitating the discussion, or teaching the lesson. One lesson was performed, rated, then discussed. Different perceptions of preservice teachers were

valued, and discussed. As an example, the construct of individual's knowledge of content is synthesized from two subscales, personal relevance and uncertainty (Figures 4.1 and 4.2).

In the first two instructional examples, Rebecca consistently rated each subscale lower than her colleagues, indicating that her perception of constructivist classrooms was very different. Indeed, as other data indicate, there is a deeper force at work that provides a framework for her perceptions. This will be discussed below.

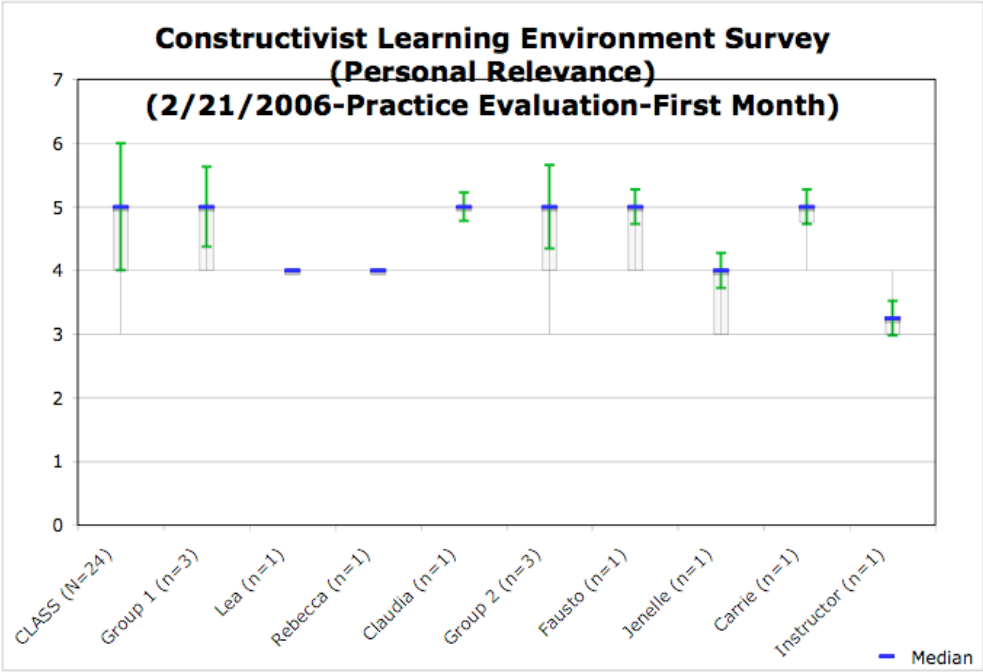


Figure 4.1: Comparison of responses on the second instructional use of the CLES (Personal Relevance)

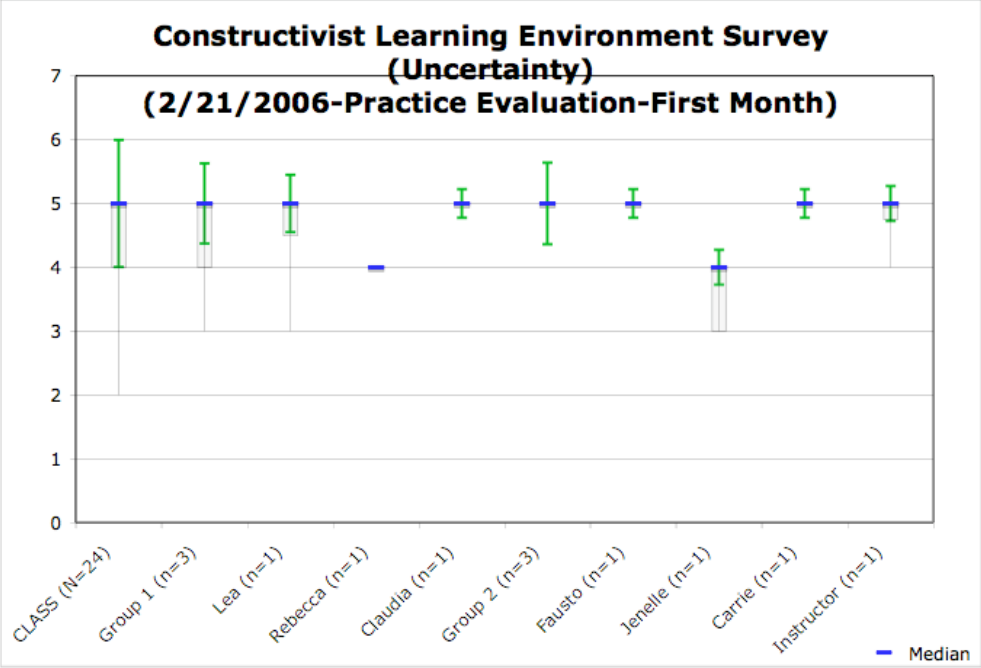


Figure 4.2: Comparison of responses on the second instructional use of the CLES (Uncertainty)

The second lesson that was rated (2/21/2006) was an archaeology lesson that, by design, exposed several Nature of Science tenets. All preservice teachers engaged in the lesson as students. Rebecca's perception of the relevance of content knowledge to everyday life (Figure 4.1) is different from some of her colleagues, with the exception of Lea and Jenelle, who seem to share her perception. The instructor, on the other hand, indicates an even lower relevance of content knowledge (relevance to student everyday out-of-school experiences). The teacher's perspective is that the lesson was designed to exemplify tenets of the nature of science by linking process skills to the tenets. (See, for example, Bell, (2008).)

Indeed, looking at Figure 4.2, Rebecca and Jenelle both seem to view uncertainty in science differently than the rest of their colleagues, and the instructor. Their

perceptions of the lesson are different than their colleagues in that their colleagues perceived the lesson as providing opportunities to experience that "scientific/mathematical knowledge is evolving and [is] culturally and socially determined" (Johnson & McClure, 2004, p. 68). Rebecca and Jenelle, however, perceive the uncertainty of science (within the lesson) to a lesser degree. We will see below that Rebecca's centrally located and strongly-held beliefs in religion impact her perceptions of science, as well as her comfort level with scientific content in the classroom. From this instrument, however, data support the inferences that perceptions of students are not matching the perceptions of the instructor, and in some instances, their colleagues. Even though they speak the same words (including terminology) in at least two languages, their perceptions shape their understanding of lessons and discussions.

Of note, are Rebecca's consistent ratings in Figures 4.1 and 4.2. The Q-sort (George, 1978) indicates that on the initial practice rating/negotiation of understanding on the CLES, Rebecca did read each question in such detail that she distinguished between questions, and thought about the meaning of each question. The second practice rating of the CLES (of a different lesson) holds no such designation. The Q-sort indicates that Rebecca did not read each question in enough detail, or with enough attention to distinguish amongst questions. (There was no variation among any of the categories, suggesting that Rebecca did not differentiate between the categories, for some reason.) This data suggests that something else is impacting Rebecca's perception of the lessons in her university class, and is exposed in the formal, semi-structured interviews. In evidence in Rebecca's interviews are tensions between science and her beliefs in religion.

THE CASE OF REBECCA-INITIAL BELIEFS

Rebecca, a native English speaker, is a traditional student seeking an elementary teaching certificate with a bilingual certification. She has passed her verbal and written

proficiencies in Spanish at the beginning of the semester. Since Rebecca is in her Intern II semester, she has had minimal teaching experience with the six assigned lessons required the previous semester. Before the semester that this research was conducted, she estimated that she had observed in schools an estimated 20% of the previous semester's class time, and 10% of the required time, teaching lessons that were not science related. Thus, she has had minimal to no observations of elementary science lessons. With minimal to no formal teaching experiences to guide her throughout the semester, she did have a moderate amount of tutoring experience one-year prior, with three years as a classroom helper. Her most rewarding experience from her Intern I semester: "Realizing that though I'm not fluent in Spanish I can communicate with the students and they still like me in spite of my deficiency" (SI_S 1/17).

At the beginning of the course, Rebecca lists a few goals for the semester. Her first is to learn "applicable methods" for teaching science to elementary school children" (ICG 1/15). She continues: "I know this goal may seem basic, but I honestly haven't the slightest idea of how to properly educate those students in the ways of science, nor do I feel confident in incorporating science into my lessons" (ICG 1/15). She also is concerned about understanding her future students abilities: "I hope to have a better grasp of the abilities of the students to know the various levels of knowledge they are capable of understanding" (ICG 1/25).

Rebecca's conception of a scientist is "A scientist is one who researches life, whether that be in plants, planets, animals, humans, etc. They experiment to gain knowledge and try to justify why things are the way they are. They answer the questions "How does this happen?" or "Why does this happen?"" (DAST 1/24). Her initial drawing reflects a genderless scientist (a blue stick figure with a green face) with pink hair, working alone in a laboratory setting with stereotypical glassware, and fuming chemicals.

Rebecca's personal concern statements from the open-ended Statements of Concern protocol also mirror her goals for the course, as they indicate Intense Stage 1: Informational concerns and Stage 2: Personal concerns.

Table 4.2: Open-ended statements of concern-Rebecca's entering concerns.

Date	SoCq	Open-ended concern statement	Notes
1/17	2	[I am concerned about] "[n]ot having the ability to communicate effectively because of [a] language barrier."	Link to "deficiency" statement above.
	2	[I am concerned about] "[n]ot having enough knowledge of the field to accurately teach."	Link to "applicable methods" statement above. Possible theme.

Rebecca constructed a diagram that represents her conception of teaching science to young children. The map contains two types of entries. First, activities or experiments are represented, with a descriptive statement that there are "more activities than readings" with "on-level explanations" (SI_G 1/17). The second entry pertains to visuals. "Lots of visuals" (SI_G 1/17) including word walls that will contain both the English word and Spanish word. Word walls are one technique to help students learn vocabulary, and also help teachers become more comfortable with academic Spanish and scientific terminology (in both English and Spanish).

Rebecca defines science as a "general blanket study/teaching of the studies of life, the mind, the ways things work, etc." (SI_S 1/17). A scientist is "one who studies/researches in the ideas of science" like biology (SI_S 1/17). Her image of a teacher seems to include a combination of the two, with "hands-on/minds-on science" defined as: "giving the students the chance to actually experience the phenomenon that you are teaching" (SI_S 1/17). The reader will note that Rebecca includes visuals in her diagram of how she conceptualizes teaching science to young children, and in her interview states "I think that the real-life visuals can be hand[s]-on things. For a student

to be able to see an example of what they just read about or learned about can be powerful in aiding their learning and processing of the information" (1/19, 2/2-follow up). She continues "[i]f they can make connect[ions] to things that they know or real-life occurrences then they have a better chance of understanding the topic at hand and being able to learn that topic" (2/2).

From her baseline interview-the interview at the very beginning of the semester and reflections, artifacts, and discussions, Rebecca outlines her "image" of a teacher as, "flexible," "unbiased," and "instinctive"/knowledgeable. She contrasts her ideal image of a teacher with herself as "deficient, "conflicted & lucky," and "confused" (1/19, 2/2).

For example, a *flexible* teacher is a teacher who can use a variety of methods at any given moment, and effectively plan hands-on lessons and direct-teach lessons at appropriate times, for appropriate topics. An ideal teacher is *unbiased*, in that she be able to "explain both sides of the [controversial] story in an unbiased way" (2/2). "The *instinctive* teacher is one who just knows 'instinctively' what to teach. [Y]ou should go with your instinct but that could and probably at times would lead you to break the rules" (2/2).

Rebecca does not see herself as unbiased in teaching evolution in science, as "I am a Christian and therefore believe that the Bible is God-breathed and therefore completely accurate. These being my beliefs I can never see myself trying to teach students things that I don't believe because I would be lying to them" (2/2). She continues: "I will say that I'm *lucky* I like kinder because we don't have to get into such topics" (2/2, emphasis added). She continues "I hold strongly to my beliefs which will conflict with what the government has said can and cannot be taught" (1/17, 2/2). Rebecca is referring to state standards, and the planning guide provided by the local school district. Rebecca also sees herself, as mentioned above, as *deficient*—specifically

pertaining to her proficiency in Spanish. “I didn’t explain it well enough or in a language that they understood or I chose an activity that was too far [above] their ability…it was kind of chaos” (2/2).

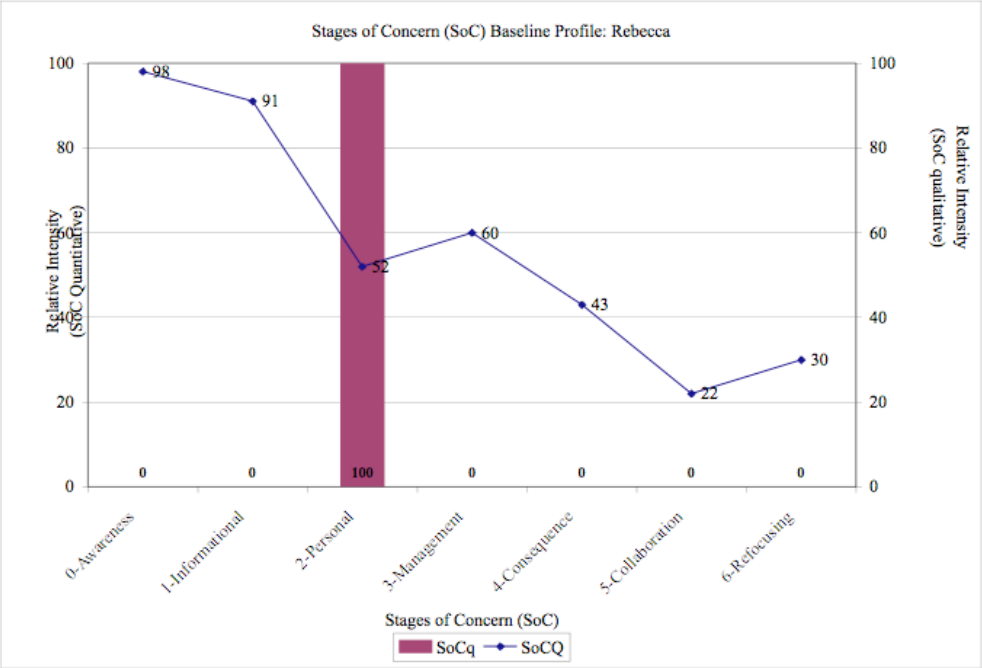


Figure 4.3: Baseline stages of concern profile: Rebecca

She is also confused with what she is learning.

> just [now] as I listened to my answer I thought about what we’ve been talking about…that students should always create their own understanding and the teacher need not feel compelled to give the student the answers. I think I’m now *confused* (2/2, emphasis added).

The above themes are also seen in her answers to Rebecca’s Baseline Stages of Concern survey. Figure 4.3 shows Rebecca’s baseline SoCQ profile, and is indicative of a non-user, as described above, yet Rebecca sees herself as a “novice” when it comes to teaching science in a constructivist manner. Also of note are Rebecca’s open-ended statements of concern, which are all categorized in Stage 2, personal concerns. These

open-ended statements provide a deeper understanding of the Stage 5 and 6 intensities, which will be discussed below.

In general, Rebecca enters into the PDS with a profile very similar to a typical non-user. She has high "self" concerns that include concerns about teaching science in a constructivist manner through social interaction. Her Task and Management concerns are significantly lower than her Self concerns, indicating that Rebecca is more interested in learning about the innovation and learning how the innovation pertains to her, and her future role as a teacher.

In detail, Rebecca's profile can be interpreted in this manner:

SoCQ (Baseline): 1/17 (Single peak user profile)

Overall Summary 1 (Baseline section): Typical non-user profile indicating little awareness/intense concern, with Primary peak intensity at 98% on Stage 0 (Awareness) prompts, and secondary peak intensity at 91% on Stage 1 (Informational) prompts. ("Typical non-user" profiles are high in Stages 0-1-2, and lowest on Stages 4-5-6.) A high Stage 0 (Awareness) peak accompanied by a high Stage 1 (Informational) peak indicates that Rebecca is not fully aware of the innovation (teaching science in a constructivist manner), and is concerned with other things at this time. Accompanied by a high Stage 2 percentage (91%) supports the inference that Rebecca is interested in learning more about the innovation, yet is not fully aware of what the innovation entails. A good Q-sort indicates that Rebecca did read each SoCQ prompt, and did adequately distinguish between the various stages.

Specific Details of Figure 4.3: SoCQ (Baseline)

Self: (0-1-2)

Stage 0-Awareness of the innovation

This is classified as a typical, single peak, non-user profile indicating little awareness of and intense concern with other things at this time, with primary peak intensity at 98% on Stage 0 (Awareness) prompts. A secondary peak intensity at 91% on Stage 1 (Informational) provides information for a more detailed interpretation of the intensity of Stage 0 concerns. ("Typical non-user" profiles are high in Stages 0-1-2, and lowest on Stages 4-5-6.) A high Stage 0 (Awareness) peak accompanied by a high Stage 1 (Informational) peak indicates that Rebecca is not fully aware of the innovation (teaching science in a constructivist manner), and is concerned with other things at this time. Yet, a high Stage 0 peak accompanied by a high Stage 1 percentage (91%) supports the inference that Rebecca is interested in learning more about the innovation, yet is not fully aware of what the innovation entails.

A positive one-two split (between Stage 1 and Stage 2) indicates a positive, proactive perspective with "little fear of the personal effects that the innovation might have" (George, Hall, & Stiegelbauer, 2006, p. 40). The "distinctly positive difference" (p. 40) is: 39% difference between Stage 1 (Informational) and Stage 2 (Personal).

Task: (3) Concerns with management of innovation

Stage 3 (Management) is slightly higher than Stage 2 (Personal), indicating that there are concerns with the management of materials and methods involved with the innovation. Being a preservice teacher in her second semester of the Professional Development Sequence (PDS), Rebecca does have seem to have concerns with

management of student behaviors and teaching in general. [Note: See SoCq (2/14) statements.]

Impact: (4-5-6)

Stage 6 "tailing-up" is evident, by an 8-percentile point difference between Stage 5 and Stage 6. This is a warning because any tailing-up evident in the Stage 6 concerns on a non-user profile "is a warning that the respondent might be resistant to the innovation" (George et al, 2006, p. 42). The warning (detection) range is indicated by a difference in Stages 5 and 6 with a "tailing-up" ranging from 7-10 percentile points. An increase of this magnitude is all that is needed to "be detectable in terms of the overall concerns of the individual" (George et al, 2006, p. 42). Incidentally, a tailing-up of greater than 10 percentage points should be "heeded as an alarm" (George et al, 2006, p. 42). So Rebecca's profile does not indicate warning signals at this point in time, yet, at this time Rebecca appears to have some idea about how to teach science to elementary students-possibly from her classroom observation experiences during her Intern I semester.

In sum, Rebecca enters into her Intern II semester having some experiences to help her make sense of new information, yet, as she does, she sees herself being confused, deficient (even though she has passed the fluency exams), and conflicted but lucky (due to her strongly-held beliefs that cause conflict between science and religion). Eventually, her confusion, and ideal image of a teacher leads her to a pseudo-crisis and she comes to question her decision to become a teacher. But at this time she is open, outgoing, and eager to learn.

Pre-collaborative Planning

Roughly one-quarter through the semester, the Stages of Concern Survey was administered after an intensive period in the course that focused on introduction and teaching about the use of inquiry in science. The text by Brooks and Brooks (1999) was used as the guiding text to teach about constructivist pedagogy, with additional activities selected from student comments, concerns, and needs throughout the first segment of the course. The next section of the course was primarily comprised of collaborative planning of lessons that would be taught during Lesson Study "episodes" as described by Marble (2004). Technically, Lesson Study begins at this time, yet, the researcher wanted to distinguish between the collaborative planning embodied in Lesson Study, and the reflection and evaluation embodied in the protocol as the episodes unfolded.

Table 4.3: Open-ended statements of concern-Rebecca's entering concerns.

Date	SoCq	Open-ended concern statement	Notes
2/14	2 2	I am concerned about properly allowing the student [sic] to construct their own knowledge while at the same time effectively conveying the information.	Possible impact for student learning, but definitely Stage 2: Personal concerns with the innovation.

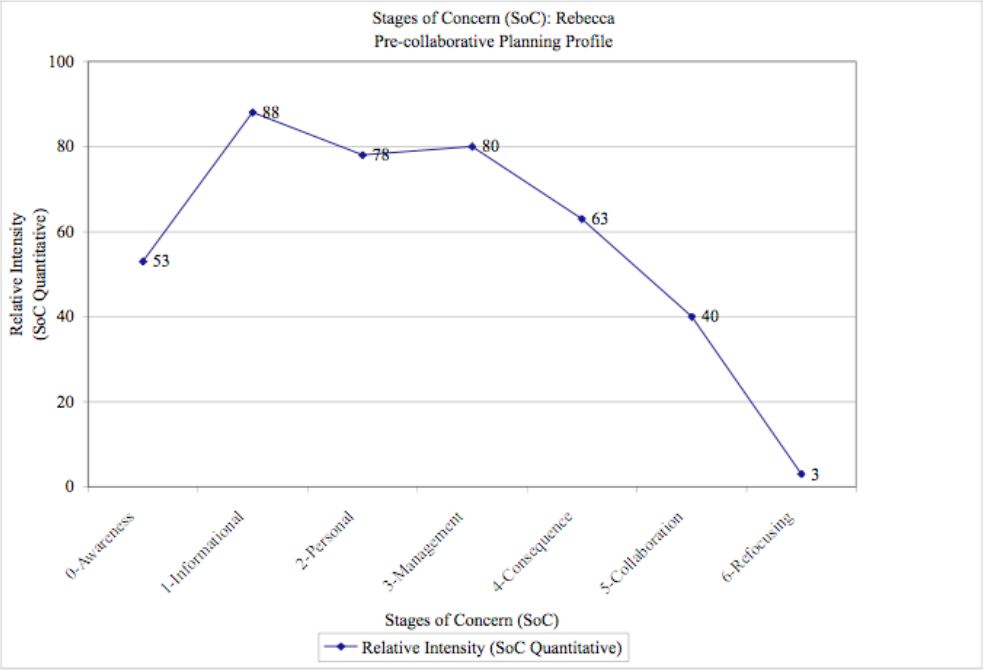


Figure 4.4: Rebecca's concerns profile for the pre-collaborative segment

Pre-collaborative Planning Overall Summary 2: 2/14 Single peak profile

Rebecca's profile follows the trend described by Fuller (1969) in that concerns in the Self concerns category begin to decrease in intensity, while Stage 2: Personal concerns begin to increase. Of note is the significant increase in Task concerns (management), from 60% to 80%, as the planning of the lessons is about to begin. At this time, students have been in their intern placements, and have a general idea as to the topic of their lessons. There is also an increase evident in the Impact concerns category (Stages 4: Consequence, Stage 5: Collaboration, and Stage 6: Refocusing). Rebecca's survey had a good Q-sort, which again indicates that she did adequately read the questions, and distinguish between the various stages of concern represented within.

Rebecca's Pre-collaborative Planning Profile in detail

Self: (0-1-2)

A drastic reduction in Stage 0: Awareness is evident at this time, which indicates that there has been a reduction in the intensity of this peak from 98% to 53% (decrease by 45%). This may be an indication that Rebecca's attention has focused on learning the innovation-quite possibly due to the looming teaching requirement in the methods course as well as teaching requirements and observations required from other PDS courses. This does not mean that awareness has waned; to the contrary, a high Stage 1: Informational concerns indicate that there is significant (Primary peak at 88%) interest in learning about the innovation. Attention to other things at this time has reduced-indicating focus on the innovation. Significant (in and out of) class time and effort have been spent learning about constructivist teaching practice, with collaborative lesson planning set to begin.

Stages 1 & 2

Informational concerns with the innovation stayed relatively intense (88%) indicating that there is a continued interest in learning about the innovation. Support for the inference of interest may be seen in a positive One-Two split, with no tailing-up evident in the Impact category.

Task: (Stage 3: Management)

A significant increase in Task concerns is also evident (60% to 80%), and reinforced by Rebecca's personal goal statement for Lesson Study: "Group goal and Individual goal: Classroom Management—to become efficient in classroom management, including materials management" (LSG 2/14).

Impact: (4-5-6)

An increase in Stage 4: Consequence for student learning and Stage 5: Collaboration with colleagues are evident at this time, possibly indicating concern for the collaborative lesson planning process. Indeed, upon reflection at the end of the course, this turns out to be a major factor: "I was most surprised by the amount of time that went into getting the groups together and planning and revising" (5/9).

SECTION II-PRE LESSON STUDY EPISODES

Interview

The second interview was given at the end of the collaborative planning section of the course, and spanned two weeks. (Weeks 7 & 8.) The third Stages of Concern Survey was given during this time, on 3/7, which is immediately before the teaching of Lesson Study episodes begins. The reader will note that all participants (all 24 students) collaboratively planned their lessons during the previous section of the course. This next section begins Phase 2: The Research Lesson portion of Lesson Study.

It is in the Research Lesson portion of the Lesson Study process where Rebecca's partner (Lea) teaches her lesson, with both Rebecca and her other partner Claudia, and myself in attendance collecting specific notes that pertain to the goals of the lesson. The notes were submitted at the end of the semester, as they were utilized during the reflection and re-planning stages of the first Lesson Study Episode (Lea's lesson). Rebecca knows that she will teach her lesson two-week's time, with Claudia's episode being taught three days after Rebecca's. In all, this group of three students engaged in the Teaching, reflecting and re-planning aspect of Lesson Study in three to four weeks time. This corresponds to the third segment of the science methods course, and roughly corresponds to weeks 8-11, including spring break during week 9.

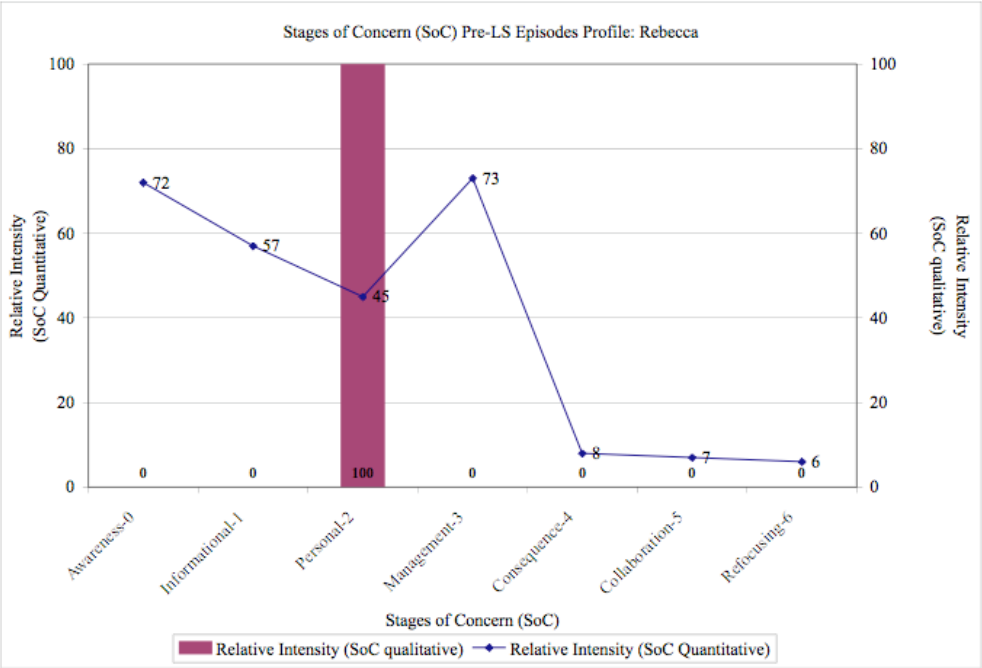


Figure 4.5: Rebecca: Pre-lesson study episodes

Table 4.4: Rebecca's open-ended statements of concern for segment 3 pre-lesson study episodes

Date	SoC	Open-ended Statement	Notes
2/28/06	2	I'm not understanding how experiments can be incorporated into all lessons.	
3/7/06	2	I'm a little nervous about being unprepared for teaching next Monday, but we've already talked about it.	Personal concerns (inadequate knowledge)

Pre-Lesson Study Episodes Planning Overall Summary 3 (3/7): Single peak profile

Overall, Rebecca shows an intense management concerns profile (Figure 4.5), with a reduction in concerns in the Self and Impact category. There is an increase in non-user concerns/awareness evident, which is potentially an indicator of little concern for, or

little involvement with the innovation (teaching elementary science in a constructivist manner). This is reinforced by a significant reduction in intensity in the Impact category, as well as open-ended statements such as "I'm not understanding how experiments can be incorporated into all lessons" (2/28), and direct statements and discussions pertaining to the amount of work demanded in other courses (some of which require reading 2 or more texts in a short time). For example "I just don't care anymore. I'm so stressed [there is] so much to do" (3/21). With a good Q-Sort, however, Rebecca's survey indicates that she did read the questions adequately in order to distinguish between the individual Stages of Concern categories. The reader will note that there is a significant reduction in concern intensity in the Self and Task categories. The reduction in Self concerns is indicative of Fuller's model of developmental progression of concerns, and the major reduction of concern intensity in the Impact category possibly indicative of the stresses Rebecca is perceiving. Also of note is a positive One-Two split in the Informational and Personal concerns category, indicating that Rebecca is not threatened by the innovation. This is supported by her demeanor and willingness to plan with her group members and instructor.

Of special note are the significantly low concern intensity in the Impact category (greater than 20 percentile points below the highest score) which indicates that these concerns do not account for much of the intensity of Rebecca's concerns. Since they are dramatically low (greater than 65 points below the peak), this indicates that Rebecca has minimal or no Impact concerns.

The second interview also merges with the SoCQ survey at this time. In her baseline interview, Rebecca outlined her "image" of a teacher as, "flexible," "unbiased," and "instinctive"/knowledgeable. She contrasts her ideal image of a teacher with herself as "deficient, "conflicted & lucky," and "confused" (1/19, 2/2).

Initial image of herself as teacher

At the beginning of the semester, Rebecca's initial image of herself as a teacher included themes such as deficient, confused, and biased. She saw her role as teacher "to effectively communicate information" (1/19) to students. At this point in the semester, Rebecca's image of herself as a teacher is "to educate my students…I am there to expand their understanding of the way the world works. I am there to broaden their view of the world. I am there to facilitate as they gather information and make new meanings of it" (2/28). Rebecca's interview and reflections indicated that she had an ideal image of a teacher who was flexible (in terms of implementation of lessons) and knowledgeable. Rebecca's image of a teacher seems to have started to change to an image of a teacher as a communicator, which includes a student's perspective. (Interview 2/28) "I am there to facilitate as they gather information and make new meanings of it" (2/28). Her image is beginning to incorporate new ideas, and become consistent with her evolving image of herself as a teacher/facilitator.

For example, a *flexible* teacher is a teacher who can use a variety of methods at any given moment, and effectively plan hands-on lessons and direct-teach lessons at appropriate times, for appropriate topics. An ideal teacher is *unbiased*, in that she be able to "explain both sides of the [controversial] story in an unbiased way" (2/2). The *instinctive* teacher is one who just knows 'instinctively' what to teach. "[Y]ou should go with your instinct but that could and probably at times would lead you to break the rules" (2/2).

Rebecca still views herself as biased in teaching evolution in science, and should follow the guidelines set out by the district, yet there are "things that…I personally wouldn't teach" (2/28). At this time, Rebecca may still see herself, as mentioned above,

as *deficient*- specifically pertaining to her proficiency in Spanish, yet she does not mention her difficulties with Spanish.

Rebecca is still confused with what she is learning in the PDS; yet her example changes. “I think that there are going to be students who don’t understand all of the material and will therefore be [left] behind. Is it fair to do that? No! Is it fair to hold everyone back for only a few students? No! So where is the medium to be found? How can you educate equally? I don’t know” (2/28). She does see value in what she is learning, however. “Whether or not I use [what I have been learning] does not show the usefulness of knowing. I now have a more broad range of information to be able to use as I see fit” (3/31). Further, Rebecca states, “I have learned a lot about taking into account other perspectives and I have learned that I will miss out on things and I won’t always see everything that goes on. I have learned that direct teaching is not the only option for teaching. I have learned to have an open mind to the ideas of others and the teaching styles of others” (3/31). This may be a tentative indication that her image of herself as a deficient teacher is beginning to change.

POST LESSON STUDY

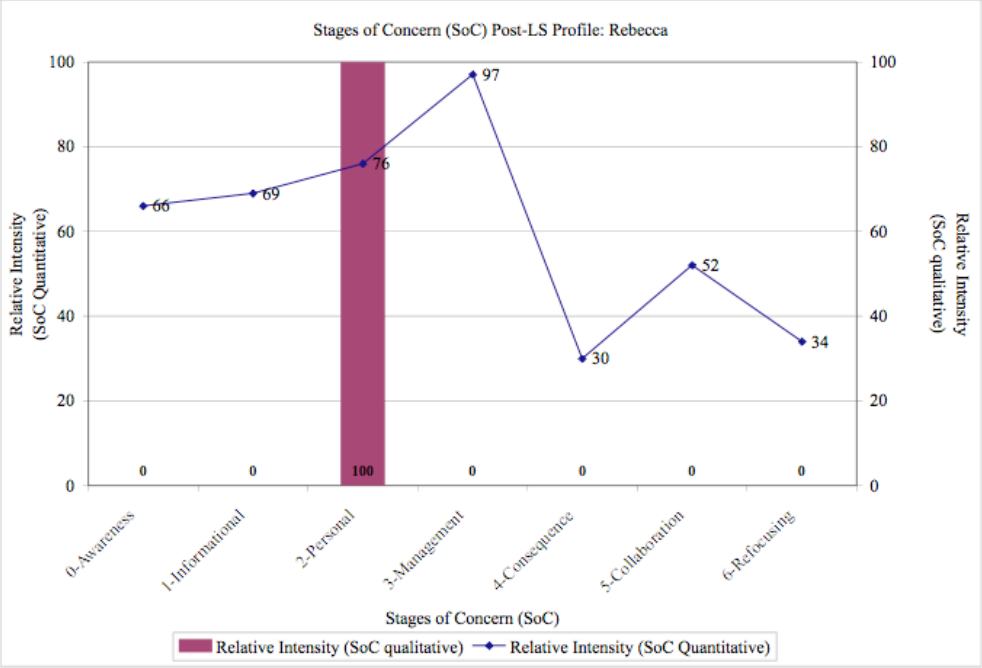


Figure 4.6: Rebecca's post-lesson study concerns profile (End of semester)

Table 4.5: Rebecca's open-ended statements of concern (End of semester)

Date	SoC	Open-ended Statement of Concern	Notes
5/2	2	"I'm concerned that I will not accurately convey the information to my students in a way that will open their minds to the world outside."	

Overall Summary (5/2) Post-Lesson Study: Intense management concerns, single peak profile.

At this point in time, Rebecca's profile indicates a slight increase in Self concerns (specifically Stage 2: Personal concerns), and an increase in the Task category indicates that, above all, Rebecca is mostly concerned with management issues during implementation of this new innovation. Learning to teach science in a way that is

different from all of her previous experiences is clearly stated in her interviews and reflections. There is also a significant increase (largest increasing Stage of Concern in this survey) in the Impact category-Stage 5: Collaboration. This is consistent with the requirements of Lesson Study at this time, and is central to the protocol. A good Q-sort indicates that Rebecca did adequately read the questions in the survey, and did differentiate between the various questions.

Rebecca's image of a teacher still has indications that Rebecca is considering a non-traditional perspective of teaching, yet, this is not the end of the story. My role is "to educate my students" and to "give them the knowledge of how the world works…but, in a way that they understand…in a way that applies to their life, as opposed to just…knowledge" (5/15) She continues to have difficulty defining knowledge, but gives a procedural example of kindergarten students learning to write, but no example for science. During her interview, she is still very unsure of what this new innovation (way of teaching science) entails, and how it affects her as a (future) teacher-as indicated by her open-ended statement "I'm concerned that I will not accurately convey the information to my students in a way that will open their minds to the world outside" (5/2). She continues to struggle with her original image of herself as a traditional teacher. The reader will note that, when pressed for examples, Rebecca rarely gives examples from science. She will usually give examples for reading, writing, or mathematics.

Self as Deficient

When reflecting on her teaching, Rebecca singles out a clip from her video, and reflects: "I learned that there was effective communication between the students and me. At this time, though, I wasn't allowing the students to talk among themselves, and I think there could have been some great idea sharing if I had allowed the students to discuss. But there was a flow of information that shows that I didn't just talk at the students but I

talked with the students" (4/29 reflection on teaching/evidence for student learning). This reflection-with self-selected video evidence-indicates that Rebecca's image of herself as "deficient" is changing. She has recognized that teaching is more than just being fluent in Spanish, which predominated her concerns and discussions at the beginning of the semester.

Teaching is complicated

At the beginning of the semester, data pointed to Rebecca having strong tendencies toward traditional teaching methods. At the end of the semester, she continues to struggle with her image of a science teacher. She has realized that "…there is a lot more preparation that goes into teaching. Just practicing teaching and watching my CT's [classroom teacher] work has made me aware that there is much preparation that goes into teaching" (5/9). She realized that teaching is not as straight-forward as her prior experiences led her to believe.

Teacher as Unbiased

Not surprisingly, Rebecca's beliefs about religion have not changed. She still is conflicted and confused about how to make sense of religion and science. She begins to take on an air of inevitability. " …I have very…set beliefs that…go against some of the things science teaches and, therefore I would not be able to teach this. I would be teaching them crap. In my opinion. I guess you would have to go with what the rules say" (5/15).

REBECCA-DISCUSSION

Rebecca is a native English speaker, a traditional student in her second-semester, or Junior year in her first year of the PDS. She is seeking an elementary teaching

certificate with a bilingual certification in Spanish. She has taken and passed written and oral proficiency tests in Spanish and English in order to be accepted into the program.

In her experiences before the previous semester in the PDS, the only experiences that may potentially be classified as classroom *observation* occurred during her 3 years as a classroom helper. During that time, Rebecca described her experiences as just this, a 'classroom helper.' She also reports that she has one year of experience tutoring students in various subjects, with the exception of science. Rebecca does not have any experience teaching science lessons during the years prior to her enrollment in the PDS.

Using an epistemological lens to expose and infer Rebecca's existing understanding of the role of the teacher, and the qualities and image of an ideal teacher (i.e. her "epistemological commitments" (Posner et al., 1982, p. 218)), Rebecca's epistemological commitments take the form of qualities that an *ideal* teacher would have. These are qualities that she judges herself, and compares herself against. Rebecca relates three basic, underlying epistemological commitments. They are: 1) a teacher is flexible and knowledgeable, 2) unbiased, and 3) instinctive. These are the fundamental assumptions (epistemological commitments) that Rebecca uses to interpret the role of the teacher, and interpret instruction within the context of a contemporary teacher education program as she learns how to plan for, and implement, inquiry in a constructivist manner.

Rebecca's epistemological commitments (her fundamental understandings of teaching, and the role of the teacher): First, the teacher is flexible/knowledgeable. This may be seen in responses like: "a teacher [is flexible/knowledgeable] who can use a variety of methods at any given moment, and effectively plan hands-on lessons and direct-teach lessons at appropriate times, for appropriate topics" (Reb_2/2). Second, the "unbiased" teacher is presented through a discussion that paints an image of a teacher teaching a controversial topic. Take, for example, evolution vs. creationism in science.

Rebecca explains, an ideal teacher is unbiased "…in that she be able to "explain both sides of the [controversial] story in an unbiased way" (2/2). To Rebecca, unbiased derives to a dichotomous distinction in which two competing sides, which in our example would be evolution vs. creationism, are taught. An unbiased teacher would teach about both, without divulging her bias. Rebecca's third epistemological commitment, the teacher is "instinctive," in that "the *instinctive* teacher is one who just knows 'instinctively' what to teach. [Y]ou should go with your instinct but that could and probably at times would lead you to break the rules" (2/2 emphasis added). Breaking the rules, to Rebecca, is teaching what is not allowed by the school, which causes her unease as she compares herself to her ideal image of a teacher.

Focusing the epistemological lens on Rebecca's image of herself as a teacher provides insight into on how Rebecca views her own knowledge. The epistemological lens helps understand Rebecca's view of her own knowledge about teaching elementary science, and provides the perspective to help understand Rebecca's **confidence** in the course, by providing insight that Rebecca finds the new information intelligible, but not plausible as it contradicts some of her fundamentally held beliefs. This provides perspective in understanding Rebecca's comfort in contributing to class discussions and group discussions, as well as progressing through the cooperative planning of lessons. The specific question that may be addressed is, is Rebecca confident in her own knowledge of content, and of teaching science in a contemporary manner at the elementary level enough to view scientific knowledge as "disputable?" If she does not view scientific knowledge as disputable, she may not question what she is learning. If Rebecca is not confident in her own knowledge, the assumption is that she will be less likely to understand the lessons in her university science methods class, for example, on the Nature of Science.

There has been, and continues to be much research on the Nature of Science Concepts, which are generally accepted as:

Table 4.6: Nature of science concepts

Table 4.6: Nature of Science Concepts
Scientific knowledge is based upon evidence. Scientific knowledge is tentative, and changes as new evidence becomes available. Scientific laws are generalizations that summarize observational data.
Scientific conclusions involve observation and inference. Scientific theories are based partly on things that cannot be observed directly.
There often is no single "right" answer in science.
Scientific theories provide the foundation on which hypotheses are built.
There is no single scientific method that all scientists follow.
Scientific conclusions can be influenced by scientists' background knowledge. Theories provide frameworks for data interpretation.

Relating to the tenets of the Nature of Science, "Science knowledge is tentative, and subject to change" was explicitly taught early in the semester. This concept is based on knowledge accepted by "Western science" and peer review procedures. The argument that is presented below is that if Rebecca's personal knowledge about science is held with a "tag" of uncertainty, then she is more likely to view scientific knowledge (and argumentation) presented in class with a degree of "indisputability." (She, then, rejects the ideas taught in the lesson.) As Tyson et al. (1997) and Johnson and McClure (2004, p. 68) define uncertainty (in science) as the "extent to which opportunities are provided for students to experience that scientific/mathematical knowledge is evolving and culturally and socially determined," Rebecca does not share this definition, nor does she understand this tenet. Thus, since Rebecca does not understand that science may be questioned, she appears to reject scientific knowledge because it contradicts her beliefs, and is less likely to question the new information (question an authority in science), and more likely to disengage with the activity. Thus, this sets up an "accept or reject" situation that will

limit her engagement with instruction and course material, therefore limiting Rebecca's interaction with the material. This, then, decreases the likelihood that her beliefs about religion and science will be modified.

Since Rebecca views scientific knowledge as indisputable and not open to interpretation (below), she views class material as being in direct conflict with her stoutly held Christian beliefs. Any lessons that she is asked to "potentially teach" in the classroom are potentially in major conflict with her strongly held beliefs and weakly held beliefs regarding scientific knowledge, or seeing herself as having a voice in discussions pertaining to science.

Rebecca also sees herself as "deficient" in fluency in Spanish, therefore Rebecca sees herself as very different from an ideal teacher. Specifically, she claims to not be fluent in written or verbal Spanish, and blames an early lesson's failure (pre-PDS) on her deficiency of language and not the complexity of the task. In her lesson (non-science), the tasks that students were supposed to engage with in each center were not clearly defined. She explains, "I didn't explain it well enough or in a language that they understood or I chose an activity that was too far [above] their ability…it was kind of chaos" (2/2).

Regardless of tests that show she is proficient in Spanish, Rebecca does not view herself as proficient. This insecurity translates into a low affect that hinders her engagement in the field (specifically with elementary students) and also translates into hesitation with her engagement in her university class, and therefore her learning of course material in her science methods course.

In addition to Rebecca's perceived deficiency in language fluency, she is also very aware that she is deficient in science content knowledge even though she has had more than the required three-course minimum for her major. The science courses that she has had are two biology, one astronomy, and one geography course. I return to one aspect

of her belief system, which holds that any teacher must understand both sides of an argument in the sciences, and use Rebecca's description of mass evolution as a representative example of the extent of her content knowledge and understanding of one side of the argument surrounding evolution. Since her science content knowledge is weak, this discrepancy between scientific knowledge and her canonical beliefs indicates a conflict between Rebecca's conceptions of an ideal teacher, her image of herself as a teacher, and her view of her own knowledge.

During a series of interviews, Rebecca discusses her ideal that a teacher must be unbiased, not conflicted, and must be able to teach both sides of a controversial topic. An example she gives to explain the unbiased nature of a teacher is "mass evolution," which she describes in the following series of exchanges. The reader will note that some exchanges occurred via email, while others occurred during interviews; however, the weakness of her content knowledge is readily apparent.

> Brian: In a public school setting, how do you decide what to teach and what not to teach?
>
> Rebecca: I would love to say that you should go with your instinct but that could and probably at times would lead you to break the rules. If you can't explain both sides of the story in an unbiased way then you should stick with what your district says. I can see this as being a problem in my future because I hold strongly to my beliefs, which will conflict with what the government has said can and cannot be taught. I'm not entirely sure I could teach with an unbiased perspective. (Reb_TBI1_1_19)
>
> Brian: I am very curious about what your beliefs are. If you don't feel comfortable with this [sharing your beliefs], will you give me an example that you can think of in which both sides of the story can be told in an unbiased way?
>
> Rebecca: I do not mind sharing at all! I am a Christian and therefore believe that the Bible is God-breathed and therefore completely accurate. My beliefs are that the Lord created the earth in 7 days and that man was created by the hand of God. We did not evolve from monkeys because God created man from the dirt of the world and woman from man's rib. These being my beliefs I can never see myself trying to teach students things that I don't believe because I would be lying to

them. I will say that I'm lucky I like kinder because we don't have to get into such topics. However [sic] there is the topic of religion and while I respect each, I don't think I could teach about them in an unbiased way because of how strongly I believe in the Bible. I couldn't talk about my faith because there would be an uproar that a teacher allowed the topic of religion to be introduced so one-sidely [sic]. (Reb_TBI1_2_2_ad)

Brian: OK. May I ask, like what would be an example that you would *really* believe strongly about? [Spoken emphasis indicated by italics.]

Rebecca: Like…mass evolution.

Brian: Um. Hm.

Rebecca: I will never teach that. [Said with conviction.]

Brian: OK. What do you mean by mass evolution?

Rebecca: Well like that we came from, uhm…anaerobic, little amoebas whether you know that or not.

Brian: Oh I see. OK.

Rebecca: Mass evolution. I mean, obviously there's a-like-…tiny evolu- like-small-scale evolution. Like, obviously viruses. [short pause] Uha, that… evolve. [laughs-] Couldn't find the word. Sorry. Obviously they evolve because they…you know-uha-bacteria they get they, like you know they kill-overcome the antibacterial, but- mass evolution. And that thing. [long pause]

Brian: OK. So, somehow you would- so what would you do if I-I know…kindergarten to second grade- I-I know. [referring to the pertinence of the discussion to the grade level.] If somebody said: "You need to teach this [mass evolution]."

Rebecca: I, would… I would say: "This is a-just a theory. One of the many theories it's not a fact. It's not proven. There's no proof for any of it. (Reb_4_15)

Brian: In your classroom, how would you decide what to teach and what not to teach?

Rebecca: [laughs]

Brian: This *is* the tough question.

> Rebecca: Well…no. Because I'm very, I mean… like in kindergarten through second it [the decision] won't be all that bad. But-like I have very…set beliefs that…uhm…go against some of the things science teaches and, therefore I would not be able to teach this. *I would be teaching them crap. In my opinion.* [laughs] [Italics indicate different tone of voice. ie: Sentences said in an off-hand manner.] So I don't know. I mean I guess you have to go with what the rules say. (Reb_4_15)

Therefore, Rebecca realizes that she can't teach both sides in an unbiased manner, and does not appear to understand (mass) evolution. Indeed, she lacks the content knowledge needed to match her ideal image of a teacher who can teach a controversial topic from an unbiased perspective. Thus, this creates a tension between the two images with the extreme nature of her beliefs about religion seemingly irreconcilable.

Rebecca has a perspective on her personal learning trajectory in learning to teach that is fairly sophisticated. She indicates (without prompting) that she is "confused," on occasion, as she listens to herself answer various questions, and relate her thoughts on teaching. Specifically, "…just [now] as I listened to my answer I thought about what we've been talking about…that students should always create their own understanding and the teacher need not feel compelled to give the student the answers. I think I'm now *confused*…." (2_2, emphasis added). In this exchange, Rebecca is beginning to show what she is learning in her university coursework, as exemplified in her answer; however, as many researchers agree, changes in epistemological frameworks take time. Rebecca, similar to Barbara's example above, is realizing that the answer she is giving neither reflects her past experiences in science, nor does it resonate with her fundamental understandings of teaching that contributed to her ideal image of a science teacher formed from personal experiences with science teachers that have taught her over the years. She has learned that the classroom teacher need not give students answers to every question asked. Indeed, she is learning to reflect student questions back to the student,

and have students suggest solutions, answers, or possible methods of finding out the answer to their question.

Indeed, Rebecca also sees herself as "Biased" but lucky. Above, she stated, "I am a Christian and therefore believe that the Bible is God-breathed and therefore completely accurate. These being my beliefs I can never see myself trying to teach students things that I don't believe because I would be lying to them" (2/2). If science content is not in the bible, or if it is not referenced in the bible, she would be extremely conflicted in teaching that topic (because it contradicts the bible), and therefore not match her ideal image of a teacher as unbiased, flexible (able to teach a subject using a variety of methods) and knowledgeable. Rebecca perceives herself as lucky, and therefore able to ignore this tension between science and religion. Thus, further reducing the depth of participation in her university coursework. "I will say that I'm *lucky* I like kinder because we don't have to get into such topics" (2/2, emphasis added).

It is important to look to the literature to see how belief structures are described, and the basis for making inferences. I introduce this method at this time because there has been sufficient background explanation with regards to instruments and procedure to support its use. One method used to infer the structure of beliefs is used by Cooney, Shealy, and Arvold (1998). They refer to Green's (1971) work that describes three dimensions of belief structures, which ultimately derives from Milton Rokeach (1968) work (Table 4.7). Cooney, Shealy, and Arvold seek to understand three things. First, they seek to understand the quasi-relational structure between beliefs which indicates whether beliefs are centrally held, or held peripherally in an individual's belief structure. Beliefs that are centrally held have a high degree of functional connections, and are theorized to be more difficult to change, for example, as when restructuring occurs through accommodation (Piaget, 1970). With accommodation of psychologically centrally located

beliefs, it is theorized that more connections have been altered, and re-formed in centrally located beliefs than in psychologically peripherally located beliefs. Beliefs that hold a low degree of functional connections are theorized to be easier to restructure. Rokeach (1968) describes centrally located beliefs as having formed early in childhood through direct experiences, and reinforced through repeated experiences that increase the functional connections. They are Type A: Primitive Beliefs with 100% consensus (the kind that any authority will confirm), and Type B: Primitive Beliefs held with zero consensus (that no authority can be in a position to understand, therefore no authority can disconfirm the belief).

Quasi-logical relationship between Beliefs	Spatial Order	Degree of Functional Connections (Milton Rokeach, 1968)	Psychological Strength	Beliefs may be clustered
Logically Primary or Logically Derivative	Psychologically Central	High	Strongly Held	Mediated by affect, perception (self/context), and/or other beliefs
	Psychologically Central	Low (Isolated)	Strongly Held	
	Psychologically Peripheral	Low	Weakly Held	
	Psychologically Peripheral	Low	Weakly Held	
Inferences based upon participant interviews and "reasoning" either in placement within an answer, or specifically stated. (Green p. 45)	Inferences based upon interview response order, triangulation from additional documents, and content of statements	Theorized by Rokeach (1960,1968)	Inferences based upon interview response order, triangulation from additional documents, and content of statements	Inferences based upon interview response order, triangulation from additional documents, and content of statements

Table 4.7: Dimensions of belief structure

Green's use of a metaphor to describe belief systems deserves closer attention. The first part of the metaphor, beliefs are arranged in a quasi-logical structure, requires that inferences be made on the basis of collected data. The inferences are either that there is a logically primary belief, with logically derivative beliefs that are based upon the primary belief. The basis of the decision to classify a belief as a primary or derivative belief need only be made on the basis that "if we press a person far enough, we may come to some belief of his for which he can give no further reason, a belief which he uses nonetheless as a reason for other beliefs" (Green, 1971, p. 44). This is classified as a primary belief, or a belief that is logically primary. Data are gathered from interviews, and additional artifacts requiring participants to provide reasons and describe the construct in question (Green, 1971, p. 44). Within the context of explanation and description, participant belief structures are revealed in the "process of giving reasons" (Green, 1971, p. 44), but do not have the requirement of following accepted rules of logic. The designation "quasi-logical" only carries the expectation that they are ordered in an individual's belief system.

Following from Rokeach's definition of belief, a belief is "any simple proposition, conscious or unconscious, inferred from what a person says or does, capable of being preceeded by the phrase, "I believe that…"" (1968, p. 113). The participant reveals in his or her explanation, specific contextual or situational expectations and structure inherent in their beliefs about that construct. It is important to note that if the primary belief is itself a derived belief, one that an individual ascribes to or knows on the basis of that authority, this indicates that "the individual's grounds for knowing are rooted in nonevidentality" (Cooney et al., 1998, p. 311; Rokeach, 1960). Nonevidentally

held beliefs are indicative of a closed belief system. Closed in the sense that beliefs may not be changed or evaluated rationally, on the basis of evidence.

The third part of the metaphor of belief system proposed by Green, belief systems may contain "clusters" (p. 42) of beliefs that are isolated from interaction with other beliefs and isolated from inspection (Green, 1971, p. 42), may offer an explanation that some preservice teachers hold psychologically-centrally located, teacher-centered beliefs about teaching, while also holding psychologically-centrally located student-centered beliefs on student learning. Preservice teachers may not consider the differing beliefs relevant, or connected.

Returning to the epistemological aspect of participant's reliance on authority as grounds for knowing something (evidentially or non-evidentially based), the Perry Scheme of intellectual and ethical development (1970) has been used to assess a participant's reliance on authority, or assess their grounds for knowing (Cooney et al., 1998; Green, 1971). Belenky, Clinchy, Goldberger, and Tarule (1986) also provide a complementary set of categories which give insight into whether beliefs are held on the basis of evidence, or whether they are held in a non-evidentially manner (Cooney et al., 1998). These will be discussed below. These categories of knowing (Belenky et al., 1986) or stages of intellectual and ethical development (Perry, 1999), in turn, support inferences on how each participant makes sense of new information learned in their university coursework, and authentic teaching experiences, and how this might present itself through the classroom teaching behaviors of participants.

Rebecca's interviews reveal that her primary beliefs (quasi-logical structure) about teaching science are ascribed to her understanding of religion. She attempts to make sense of her university instruction, and her science lessons, by referencing canonical text. In interviews, Rebecca exhibits a major tension with respect to resolving

this disequilibrium. Indeed, Rebecca's strongly held, centrally located belief about religion impacts beliefs in other constructs, such as the role of the teacher, and decisions made by the classroom teacher. Thus, Rebecca holds her belief in the canonical text with great psychological strength, designating it as a core belief, or psychologically central belief. This is the second part of Green's metaphor of beliefs. The spatial location of the belief is determined by how strongly it is psychologically held (Green, 1971, p. 46).

For example, Rebecca's psychologically centrally located, strongly held belief about teaching science (a teacher-centered belief about the role of the teacher) is impacted by the strength of her (also psychologically central) belief about the authority of the canonical text. This serves to create tension, with no resolution, or guidance offered by her university instructor. She does not want her students to be asking questions about the science she is teaching, as she may not be able to answer the questions, given her weak grasp of the principles of science, and weak content knowledge.

As mentioned above, Rebecca's primary belief about student learning is classified as psychologically centrally located as well. Indeed, it appears to be separate from her primary belief about the role of the teacher. Her beliefs about student learning, too, are not held with as much conviction as her beliefs about religion. Thus, they are called into question, and marginalized in the context of science lessons. That she feels she would be "lying" to students if she taught them content that was not in the bible—even though she would be "following the rules" leads her to never need to examine her beliefs in relation to perceived tensions. (After all, she knows what is causing the tension.) Thus, Rebecca seems to enter into the PDS with the Perry stage of Multiplicity Pre-legitimate (Perry, 1999) or be consistent with the Belenky et al category of Received Knowledge (Belenky et al., 1986).

The Perry scheme generally consists of four generalizations, which are further delineated into nine sub-categories. The four generalized categories are Dualism, Mutiplism, Relativism, and Commitments in Relativism. Each has several sub-categories that further expand on concepts of Authority, Uncertainty, and perceptions of self.

Belenky's five epistemological categories were derived from "epistemological *perspectives* from which women know and view the world" (Belenky et al., 1986, p. 15, original emphasis). The categories were constructed using the metaphors of voice and silence. Belenky et al had women tell them "about their views of the world, and their place in it" (p. 19). In interviews, women revealed to Belenky et al "how much they could hear and learn from the ordinary and the everyday" (p. 19). The categories are summarized as follow:

> *silence*, a position in which women experience themselves as mindless and voiceless and subject to the whims of external authority; *received knowledge*, a perspective from which women conceive of themselves as capable of receiving, even reproducing knowledge from the all-knowing external authorities but not capable of creating knowledge on their own; *subjective knowledge*, a perspective from which truth and knowledge are conceived of as personal, private, and subjectively known or intuited; *procedural knowledge*, a position in which women are invested in learning and applying objective procedures for obtaining and communicating knowledge; and *constructed knowledge*, a position in which women view all knowledge as contextual, experience themselves as creators of knowledge, and value both subjective and objective strategies for knowing (p. 15).

For Rebecca, her sense of authority (as grounds for knowing) is derived from religion, not her classroom teacher, or university instructor. She does not perceive her own voice or self as a contributing factor, or factor in a negotiation. As she begins to learn new pedagogy in her university course, it then evolves into a pseudo crisis during the semester, but seems to resolve itself as she answers many more questions with "I don't know. That's my answer" (Rebecca Interview TBI 3 6/21/2006). When asked how she would decide what to teach and what not to teach, she responds "…I guess you would

have to go with what the rules say" (Rebecca Interview TBI 3 6/21/2006). She never undergoes a restructuring of her beliefs, and still defers to religion as the authority, yet is resigned to follow the guidelines and rules in a public school even though she feels she would be lying to her students.

In sum, an epistemological lens reveals the basic epistemological commitments, or fundamental understandings that Rebecca holds about teaching and teachers in science classrooms. In short, Rebecca is extremely conflicted in that she views her own science content knowledge as deficient in breadth and depth, which indicates barriers to learning how to teach science in a contemporary manner. Also, she initially sees herself as violating her three fundamental assumptions with respect to teacher qualities. If this was the only lens that was used, by inference, Rebecca would be likely to find the new methods of teaching initially implausible, and therefore her learning to teach science in a contemporary manner would be impacted. In addition, with only one lens, there might not be an avenue for change perceived by the university instructor.

Recall that Posner et al's discussion of multiple methods that teacher educators may use to have new information become plausible to the learner is related to teacher educators identifying prior beliefs, knowledge, and images of teaching, and using that information to craft experiences for reflection. Of the many pathways teacher educators may use, consistency of new information with prior conceptions is key. New information needs to be veridical with initial conceptions, prior knowledge, beliefs, and images of teaching, veridical with past experiences, as well as what preservice teachers view teaching to be like (their expectations of rules of teaching and rules of engagement in instruction), and if they find the new methods able to solve problems that they perceive will be encountered (p. 218). Note: Learning, from Rebecca's point of view, will be a

gradual, and "piecemeal affair" (Posner et al., 1982, p. 222) as indicated by the Teacher Beliefs Interview.

Expectational Lens

This, however, is not the whole story on Rebecca's profile. An expectational lens provides another perspective on Rebecca's understanding of the nature of science teaching, the role of the teacher in the classroom, and the role of student learning in classrooms. This lens is intended to provide insights into the framework through which Rebecca interprets new information, responds to new situations, and formulates her understanding of new information taught in her university course. It helps to expose the "rules" that Rebecca perceives to be in operation in classrooms. Therefore, the fundamental focus of this lens is to seek to understand Rebecca's understanding of the "rules" of teaching, classrooms, and student learning in classrooms. Within these rules, Rebecca conceptualizes herself, and ultimately decides how to interpret or interact within these new contexts or situations. This also applies to the framework that aids Rebecca as she interprets and understands new information. Thus, it is Rebecca's expectations (learned, perceived, or unconsciously held) and understanding of the rules of engagement that are important to understand with the use of this lens.

For example, the Teacher Beliefs Interview (TBI) may be coded according to the informational maps provided by Luft and Roehrig (J. Luft & Roehrig, 2005; Roehrig & Luft, 2006), separated into two sections, and presented as in Table 4.8.

Table 4.8: Rebecca's TBI profile

Table 4.8: Rebecca's beliefs about teaching

1. How do you maximize student learning?
2. How do you describe your role as a teacher?
4. In a public school setting, how do you decide what to teach and what not to teach?
5. How do you decide when to move on to a new topic in your classroom?

Teacher-centered--------Student Centered

	Trad.	Instr.	Trans.	Early Const.	Exper. Constr.
Interview 1[as]	2	1 4 5[dk]			
Interview 2[as]	2 5[dk]	1 4[dk]			
Interview 3	2[dk] 5[dk]	1[dk] 4[dk]			

x' Primary response category (Most responses)
x" Secondary response category
x'" Tertiary response category (Fewest responses)

Rebecca's beliefs about learning

3. How do you know when your students understand?
6. How do your students learn science best?
7. How do you know when learning is occurring in your classroom?

Teacher-centered--------Student Centered

	Trad.	Instr.	Trans.	Early Const.	Exper. Constr.
Interview 1[as]		3 6		7	
Interview 2[as]	3[dk]		6	7[dk]	
Interview 3			3[dk] 6[dk]		7[dk]

* missing data
[as] asynchronous interview
[dk] "Don't know" as initial answer.

The TBI may be divided into two constructs, one that exposes participant beliefs about teachers, the role of teachers, and what (expectations/beliefs) teachers use to guide decisions of practice. The second construct exposes participant beliefs about student learning in science, and differences in learning versus understanding (Fletcher, 2006). Together, these two constructs provide insights into the expectations of individual participants, and help make sense of participant learning of new information in their university classrooms.

Initially, Rebecca's perception of the nature of teaching science to elementary students, is a view of teaching as "transmission" (J. Luft & Roehrig, 2005). Therefore, as she attempted to understand teaching from constructivist perspective, Rebecca used her understanding and terminology from her traditional teaching experiences. In fact, as we look at the three interviews listed in Table 4.8, we can see that Rebecca's beliefs about teaching and the role of the teacher consistently stayed within the teacher-centered categories. This is the only perspective that she understands, so as she struggles to make

sense of the many instructional activities, exemplary lessons presented via videotape, and intense discussions with her teaching group, Rebecca seems to filter her intake of new information, and remember only the situations that make sense to her. Indeed, she seems to learn new information in a way that confirms her expectations. Evidence of this may be seen in her answers to questions posed throughout the semester. As she progressed through the semester, her answers were more likely to begin with "I don't know" or "this is a difficult question to answer" indicating that she could not relate to the material at the most basic level. Data do indicate that Rebecca is engaged with the material (because she has to learn to teach science-reference her initial course goal, and Stages of Concern Questionnaire responses), yet she struggles to relate new material with past experiences, or with her traditional teaching experiences in her concurrent internship. Also of note are her answers on the CLES, specifically the Q-Sort of her responses to the second CLES. Recall that between the first use of the CLES and the second use of the CLES (to rate different lessons), the Q-Sort of Rebecca's answers indicated a major change in her attention to individual questions. Rebecca, in fact, rated each answer as 4, with the exception of a slight variation in her response of the first few prompts.

Even though Rebecca is engaged with the material, she is not finding the information and new teaching methods plausible. Since she does not find the material plausible, she most likely does not see the fruitfulness of the new pedagogy use in the classroom (Posner et al., 1982). That is, she does not see any use for a new pedagogy that will not help her address her problems and concerns as she looks forward to her student teaching semester.

Just the use of an expectational lens, in Rebecca's case, seems to provide more questions than answers. She seems to become more uncertain about teaching science at the elementary level—across all questions in the interview, thus the resulting inference is

that the current instructional pedagogy used for instructing Rebecca is not hitting the mark, or producing the results needed to help Rebecca teach in a contemporary classroom. Looking to the literature, a third lens is suggested by Tyson et al (1997). This lens is the Social/Affective lens.

Social/Affective Lens

According to Pintrich et al's (1993) discussion, choice of task, level of engagement, and willingness to persist are three traditional "behavioral indicators of motivation" (p. 168). Thus far, Rebecca seems to be motivated (for whatever reason) as she strives to make sense of the new information and pedagogy learned in her university course. Prior (canonical) knowledge seems to problematize Rebecca's learning since it does not appear to be veridical, as her experiences in her Science Methods course do not seem to match her prior conceptions, or her perceptions of reality. (See for example, the discussion of Rebecca's ideal image of a teacher (a teacher is unbiased), above, and her subsequent tensions of seeing herself as flawed). Her strongly held, centrally located beliefs about religion create tension as Rebecca strives to reconcile her weak science knowledge with canonical knowledge. Further, her learning of new information is mediated by her level of prior science content knowledge (comprehension) and comprehension of knowledge of the biblical text. Her attention to content in her university course appears to be marginalized by her science content knowledge in that her science content knowledge is so weak that Rebecca does not know how to engage with the lessons, or prepare for teaching. Analysis of interview transcripts, reflections, and transcripts of planning sessions presents a few fragments where Rebecca begins to talk about content (regarding her lesson on air resistance, or lessons in her university course on simple circuits, archaeology, or geology), yet, most end in the same manner as the example presented above (Reb_4_15, describing "mass" evolution). Indeed, minimal

content knowledge may be a motivating factor causing her to reschedule her lesson a few times during the teaching period of Lesson Study. Referencing the Social/Affective lens, Rebecca will purposefully attend to the instruction from her university coursework that directly (explicitly) helps her resolve her intense concerns. (See for example Figure 4.7, which depicts Rebecca's shifting concerns from a non-user profile to a management profile toward the end of the semester and teaching cycles.) Once her concerns are addressed, Rebecca's focus shifts to new concerns, as evidenced by a shift in the intensity of her primary concerns. This fits Francis Fuller's (1969) experiential based developmental model (discussed below), as well as George et al's (2006a) theoretical model presented in the CBAM.

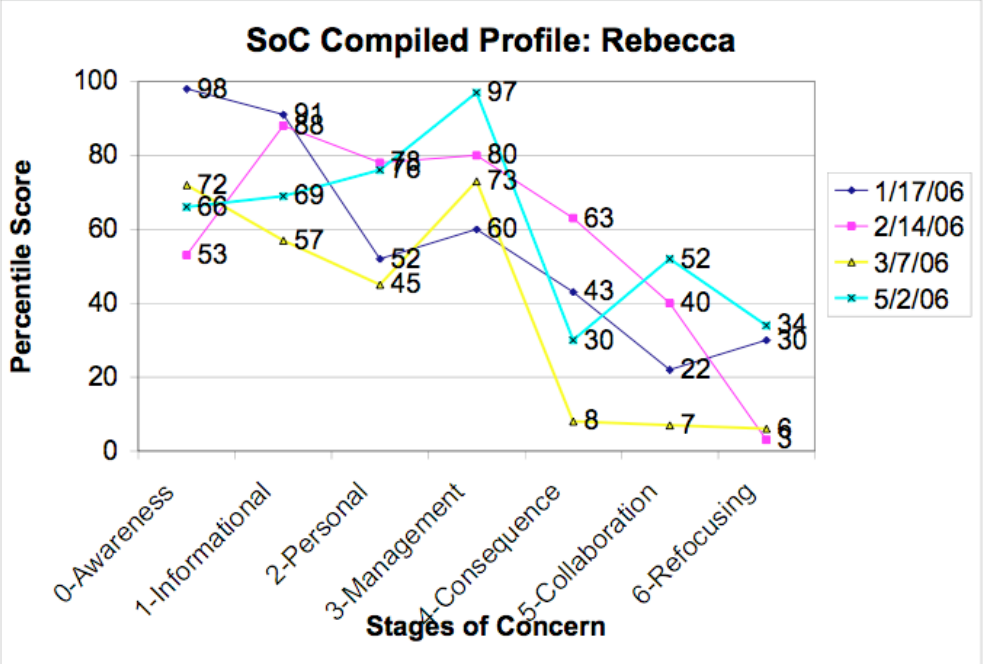


Figure 4.7: Compiled Stages of Concern Profile for Rebecca

In Rebecca's case, her general baseline profile indicates a single-peak "nonuser profile" (George, Hall, & Stiegelbauer, 2006b, p. 38). Non-user profiles are characterized as having intense self-concerns, with task and impact concerns not as intense. Rebecca, has intense "self" concerns (Stages 0, 1, & 2), which include intense informational concerns about teaching science in a constructivist manner. She is very interested in how to enact hands-on/minds-on activities that allow students opportunity to construct their own knowledge (individually) through social interaction. The reader will note that Rebecca does not have intense concerns regarding task (Stage 3) and impact (Stages 4, 5, & 6) concerns, as they are significantly lower in intensity than her Self concerns. This indicates that Rebecca is more interested in learning to teach science using a constructivist pedagogy, and learning how the pedagogy pertains to her, and her future role as a teacher. This, however, does not indicate the reasons that Rebecca is interested in learning to teach science. To extend this inference, we need to refer to her initial course goal:

> By the end of this semester I hope to have learned applicable methods for teaching science to elementary school children. I know this goal may seem basic, but I honestly haven't the slightest idea of how to properly educate those students in the ways of science, nor do I feel confident incorporating science into my lessons. I hope to have a better grasp of the abilities of the students to know the various levels of knowledge they are capable of understanding. (ICG_Reb_1/15/2006)

Taking a closer look at Rebecca's nonuser profile, there are indications of little involvement with the new pedagogy, as evidenced by primary peak intensity at 98% on Stage 0 (Awareness) prompts. This seems logical, as Rebecca has never had instruction about constructivist pedagogies, nor has she observed science lessons taught with this new pedagogy. Even if Rebecca had previously observed lessons taught with constructivist pedagogy, the above lenses indicate that she would not have understood the

distinct differences between the contemporary method, and her traditional image of teaching.

Further deconstructing Rebecca's profile, a secondary peak intensity at 91% on Stage 1 (Informational) prompts is evidenced. 'Typical' non-user profiles are high in Stages 0-1-2 (Self concerns), and lowest on Stages 4-5-6. In Rebecca's profile, a high Stage 0 (Awareness) peak accompanied by a high Stage 1 (Informational) peak indicates that Rebecca is not fully aware of the innovation (teaching science in a constructivist manner), and she is also concerned with other things at this time. Intense Stage 1 and Stage 2 concerns (91%) support the inference that Rebecca is interested in learning more about the innovation, yet is not fully aware of what the innovation entails. A good Q-sort indicates that Rebecca did read each SoCQ prompt, and did adequately distinguish between the various stages, thus she is engaged with the material, and with the course.

The difference between Stage 1 (informational concerns) and Stage 2 (personal concerns), is called the "one-two split" (George et al., 2006a, p. 40). A positive one-two split is indicated by the Stage 1 concern intensity larger than the Stage 2 (personal concerns) intensity. This positive split indicates a positive, proactive perspective with "little fear of the personal effects that the innovation might have" (George, Hall, & Stiegelbauer, 2006, p. 40). This alone indicates that Rebecca is engaged with the instruction, and not threatened.

Noting that the task category, Stage 3, consisting of concerns with management of innovation, shows that Stage 3 (Management) is slightly higher than Stage 2 (Personal) concerns. This indicates that there are concerns with the management of materials and methods involved with the innovation; however, since it is not the most intense concern, it does not preoccupy Rebecca to the extent that her informational concerns do. Being a preservice teacher in her second semester of the Professional Development Sequence

(PDS), Rebecca does seem to have concerns with management of student behaviors and teaching in general, as her open-ended statements indicate. “I am concerned about properly allowing the student [sic] to construct their own knowledge while at the same time effectively conveying the information” (Reb_2_14 SoCq). There is another interpretation that indicates a possible impact for student learning; however, in the absence of an emphasis on impact for student learning, this statement is coded as Stage 2.

Looking closely at the impact category, it is comprised of three stages. Namely, Stage 4: Consequence (for student learning), 5: Collaboration (with colleagues), and 6: Refocusing (modification of the innovation to fit different situations), Stage 6 clearly shows a “tailing-up” (George et al., 2006a, p. 42) signature evidenced by Stage 6 being more intense than Stage 5. In Rebecca’s profile, this is shown by an 8-percentile point difference between Stage 5 and Stage 6. Any tailing-up is a warning. Any tailing-up, however small, evident on a non-user profile “is a warning that the respondent might be resistant to the innovation” (George et al, 2006, p. 42), and needs attention.

Rebecca’s profile does not indicate alarm signals at this point in time, yet, at this time Rebecca appears to have some idea about how to teach science to elementary students-possibly from her classroom observation experiences during her Intern I semester, or from previous experiences. In sum, Rebecca is interested in learning to teach science. To her, with her minimal-to-no experience with science teaching, any pedagogy will be interesting, and worth pursuing. Indeed, her personal goal for the course supports this inference: “By the end of this semester I hope to have learned applicable methods for teaching science to elementary school children. I know this goal may seem basic, but I honestly haven’t the slightest idea of how to properly educate those students in the ways of science, nor do I feel confident incorporating science into my lessons. I hope to have a

better grasp of the abilities of the students to know the various levels of knowledge they are capable of understanding" (Reb_IG_1_15).

Summary from the use of lenses

Rebecca enters into her Intern II semester having a minimal number of experiences outside of her own schooling in elementary school to help her make sense of new information. She sees herself as confused, deficient, and conflicted but lucky because, in her target grade level (Kindergarten) she will not have to teach topics that conflict with her strongly-held canonical beliefs that cause conflict between science and religion. Eventually, her confusion, and tension between her image of herself as a teacher, and her ideal image of a teacher leads her to a pseudo-crisis and she comes to question her decision to become a teacher. This will be described below. However, at that time she was open in her discussions, outgoing, and eager to learn.

The epistemological lens reveals Rebecca's fundamental assumptions about teaching that she uses to help make sense of new pedagogy, and also reveals that her concept of the role of the teacher differs significantly from what she is learning about the role of the teacher in her university course. This lens reveals that Rebecca is aware that she is very different from the image of the ideal teacher. In addition, since she is not confident in her science content knowledge, and extremely conflicted with respect to selection of topics to teach, Rebecca is likely to find the new methods implausible, because she is having difficulty reconciling her personal image of herself with the ideal image of a teacher she has come to expect. Because of these tensions, Rebecca is less likely to deeply learn about the new pedagogy, and alter her beliefs to any great extent.

The expectational lens indicates the perspective through which Rebecca views and interprets new information, instruction, and experiences. It reveals a very traditional framework, or set of expectations that are closely tied to her past experiences as a student

in K-12 education. When used to interpret Rebecca's interviews, this lens reveals that she is dissatisfied with the comparison of herself as a teacher to her ideal image of a teacher. This indicates a major conflict that will need to be addressed. A conflict that she is ignoring by saying she is "lucky" in that she intends to teach in early grades. According to Posner et al (1982) this realization is the first step in conceptual change, or learning that may result in a major epistemological reorganization. The second step in conceptual change, according to Posner et al, is that Rebecca must find new instruction and new pedagogy intelligible. Analyzing the data reveals that Rebecca interprets any new information through a traditional lens that is based on a transmission framework of teaching—albeit troubled by her strong beliefs in religion. Since constructivist pedagogy is very different from any prior experiences, Rebecca has a difficult time understanding the new information. Thus, she does not find the new information intelligible (it does not fit into her existing conceptions), which rules out the third step, new information should be plausible (Posner et al., 1982). She must find the new information and pedagogy plausible, and able to solve problems that she perceives as she learns to teach science. Since Rebecca has a difficult time conceptualizing the new pedagogy with her existing framework, she is unlikely to find it capable of solving problems that arise in everyday instruction. Last, since Rebecca does not find the new pedagogy plausible, she most likely will not find it fruitful (Posner et al., 1982), or worth taking the time to learn about it, or reorganize her existing traditional (transmission) framework.

As indicated by the expectational lens Rebecca does not seem to understand constructivism (or constructivist pedagogy), and becomes confused when attempting to discuss the new pedagogy. This curtails her deep engagement with the new information for any length of time, although she does make the attempt, and is open about talking about her perceived conflicts. Even though she uses correct terminology, the meanings

that she ascribes to the words, and how the words fit into her existing schema are not consistent with how her university instructor uses the words. Further, in conversations with classmates, this mismatch is also prevalent. All are using the correct terminology without a shared understanding.

Applying the Social/Affective lens to Rebecca's case reveals that she is selective as to the information she engages with. Using the Stages of Concern model combined with Fuller's work on experiential developmental progression, Rebecca chooses to engage with instruction that pertains to informational-type instruction. Since use of an expectational lens reveals that she has difficulty in understanding a pedagogy that is radically different from the one that underpins the foundational understandings of the role of the teacher, and student learning in science classrooms, she does not make much sense of the new pedagogy. With non-veridical information, Rebecca is most likely to discard the new pedagogy, and continue with her traditional approach to teaching. Indeed, the increase of use of the phrase "I don't know" in her interviews in the middle and end of the semester is a good indication of this.

The Social/Affect lens depicts a shift in Rebecca's concern intensity. Over the semester, Rebecca's concerns profile shifts from a single-peak, non-user profile to an intense management concerns profile, which according to Fuller (1969) and George et al (2006a), are indicative of a shift in Rebecca's focus in the context of learning to teach in a new manner. Still, there is not a corresponding shift in Rebecca's epistemological commitment. In the Perry scheme, this shift would be visible in the meaning Rebecca reveals in her discussions and interviews. This shift, according to Perry (1970), would be from Multiplism to Relativism. This shift in the Belenky model would exhibit itself in a transition from received knowledge, to shared knowledge. Absent this shift between categories or stages, Rebecca still does not take possession of this new pedagogy in a way

that allows her to see herself as an authority, or even a knowledgeable teacher when teaching science. This shift, according to George et al (1978), would be indicated by a reduction in concern peak intensity in the self and task categories, and at least one intense peak in the impact category. Such a shift in concerns would indicate a change in affect, and would also be visible as a change in her epistemological beliefs, and possibly her expectations. A shift in all three would be indicative of a reorganization or restructuring of her belief structure.

As Pintrich, Marx, and Boyle (Pintrich et al., 1993) discuss the paradoxical role in conceptual change "students who possess little prior knowledge in an area would have few barriers to learning new concepts, yet the literature on learning shows clearly the value of prior knowledge" (p. 191), "prior knowledge which may impede learning through the alternative frameworks that students possess..." (p. 191). For Rebecca, it is not prior science content knowledge, or prior knowledge of constructivist pedagogy that directs her learning, it seems to be a combination of her psychologically centrally located beliefs about religion, and her view of religion (as an authority) as grounds for knowing that impede her learning and engaging with new information taught in her university course. Having centrally located (and highly connected) beliefs about religion that are strongly held, coupled with the missed attempts of engagement from her university instructor, Rebecca did not seem to have much chance to begin reconciling the tension that clearly affected her during the later weeks in the semester. To be sure, she even stated "I will say that I'm *lucky* I like kinder because we don't have to get into such topics" (2/2, emphasis added). She continues "I hold strongly to my beliefs which will conflict with what the government has said can and cannot be taught" (1/17, 2/2). Further driving her decision seems to be her weak content knowledge.

THE CASE OF LEA- INITIAL BELIEFS

Lea, a native bilingual speaker, grew up speaking Spanish at home, and English in school. She learned English at a very young age, and was used to translating for her parents. Entering in to the semester, Lea states her main concern as "whether I use the correct science terminology in both English and Spanish. I would hate to give students the incorrect word in Spanish" (Lea SI_G 1/17/2006). She enters into the PDS with no formal teaching experience, with only an estimated 5% of the previous semester spent observing in actual classrooms for her university course, Foundations of Bilingual Education. According to Lea, the most rewarding thing that happened to her during her observations from the previous semester was that "I loved seeing children eager to learn and share their ideas among their peers" (Lea SI_G).

> Regarding her conception of teaching science, Lea's initial goal for the course is
>
> to have improved my elementary science methods skills, and to become more efficient in confidently presenting a science lesson and have my students gain an understanding of what is being taught." She continues, " I hope to get a clear idea of what it takes to teach a science lesson such as a set outline for beginners or just helpful tips on how to keep a class engaged in the lesson. I also hope to overcome my shyness and become more confident while teaching students (Lea ICG_1/17/2006).

She describes her conception of science in that students "are taking part in a lesson by actually performing an experiment or conducting research to learn something science. It's about taking control and experiencing something first hand, rather than just have someone telling you" (SI_S 1/17/2006). This concept is important to Lea, and seems to drive her thinking about planning lessons. Indeed, she defines science as "the study of the natural world" (SI_S) that involves biology, chemistry, physics, and engineering fields (SI_S).

With her definition of inquiry, Lea relates inquiry as a process of asking questions and doing research, a process of trying to find out more information about a certain topic. This can be seen in additional artifacts, such as her picture and description of what it means to teach science to young children. In her diagram, a teacher uses hands-on activities in which "kids make observations," (SI_S) and "teaches students to do research" (SI_S) like scientists. She includes scientific glassware with escaping bubbles, as well as a picture of a text, with the label "reference." She labels this section of her diagram with the words "be knowledgeable enough that students are comfortable seeking advice" (SI_S), and "persistence" (SI_S), in reference to characteristics of science teachers.

Within this diagram are clues to how Lea imagines her classroom to look, as well as how a teacher is supposed to teach science. To her, classrooms will have bulletin boards that are "all about science" hinting at a theme in which a teacher relies on visuals to teach lessons. The teacher, in addition to using bulletin boards as a strategy for teaching, also uses group work.

To summarize, Lea seems to be a typical non-user, with little idea as to what her students are doing within the context of an inquiry lesson. According to the Draw A Scientist Activity (Farland & McComas, 2007) she has a sensationalized image of a scientist that she ascribes to, as well as an image of a teacher who cares about student progress, and seeks to have students gain deeper understandings of specific topics through the use of activities and lessons. She explains that, when she thinks of the act of teaching, she recalls lessons when she was in elementary school. The lessons would begin and end with the teacher reading a text to students, but is not clear as to what happens in the main part of the lesson besides working on worksheets.

When she begins to think about teaching in a non-traditional manner, her concerns profile (Figure 4.8) is similar to a non-user concerns profile, with a small peak indicating concerns about collaboration. At this time, this may be due to Lea's uneasiness at the requirement of the assignment, which requires group planning of lessons, required by Lesson Study protocol.

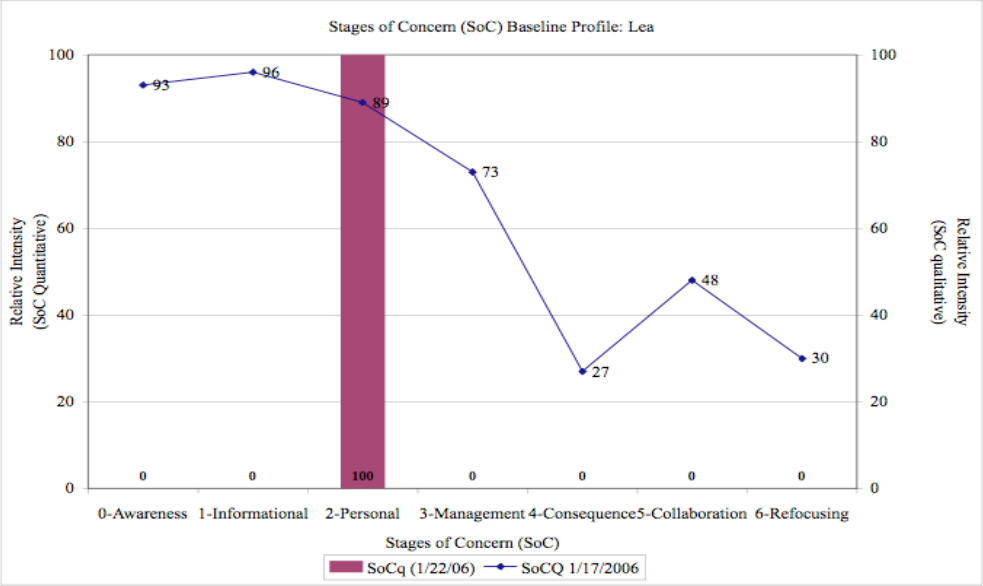


Figure 4.8: Lea's initial concerns profile

When interpreted with Lea's background, initial course goal and concerns, the concerns profile is relatively straightforward. It is a single-peak, informational concerns profile. Lea is interested in learning to teach in a new way, as well as concerned about keeping student attention during the lesson.

Date	SoCq	Open-ended Concerns Statement
1/22/2006	2	I am most concerned about whether I use the correct terminology in both English and Spanish. I would hate to give students the incorrect word in Spanish.
	2	I am also worried about losing their attention, and being boring.
	2	I want to be fun and engaging, but I really want them to learn.

Table 4.9: Open-ended stages of concern

The Teacher Beliefs Interview profile (Table 4.10) indicates two major things at this point in time. Lea's traditional beliefs about teaching are triangulated with her image of teaching (drawn pictures and written explanation).

Table 4.10: Lea's beliefs about teaching						Lea's beliefs about learning					
1. How do you maximize student learning? 2. How do you describe your role as a teacher? 4. In a public school setting, how do you decide what to teach and what not to teach? 5. How do you decide when to move on to a new topic in your classroom?						3. How do you know when your students understand? 6. How do your students learn science best? 7. How do you know when learning is occurring in your classroom?					
Teacher-centered------Student Centered						Teacher-centered------Student Centered					
	Trad.	Instr.	Trans.	Early Const.	Exper. Constr.		Trad.	Instr.	Trans.	Early Const.	Exper. Constr.
Interview 1[as]	1 2	4 5				Interview 1[as]		3 6	7		
Interview 2[as]		1 4'	2 4	5		Interview 2[as]		3 6 7			
Interview 3	1 2 4	5				Interview 3	6	3	7		
x' strongest response x" second strongest response x'" weakest response						* missing data [as] asynchronous interview					

Table 4.10: Lea's TBI profile

Exemplified by the quotes,

> "I plan on maximizing student learning in my classroom by presenting them with information, and having them work in groups to perhaps conduct a small experiment. If I conducted a small experiment with my students I would want them all to be seated at their desks. I would be standing before them and for example, reading a book and I would engage the children by asking them questions." (Lea_TBI_1)

Lea's experiences definitely seem to have shaped and guided her conception of teaching in classrooms. What is different, however, from her beliefs about teaching, are her beliefs about student understanding. Her definition of student learning is related to her definition of understanding, and is also traditional, but her sense of evaluation is very different than would be assumed by a transmission model of instruction. Lea has a notion that, in order to assess student learning (how she knows learning is occurring in the classroom), she values discussion amongst students. "I think I will know learning is occurring when students are engaged in discussion and are able to make projects in class or write about it [the projects]" (Lea_TBI_1). Thus, there is an aspect of subjective evaluation of student learning which requires students be actively engaged in the lesson. Indeed, this may be seen in her written description, and representation of her conception of "what it means to teach science to young children" (SI_G_1/17).

Pre-collaborative Planning

Against the background of Lea's traditional beliefs about teaching and transitional beliefs about assessing student learning (as assessed by the TBI), the first few weeks of the university course were directed at learning about inquiry, and how to teach inquiry lessons. After an intense few weeks of learning to teach an inquiry lesson, Lea's concerns profile (Figure 4.9) has evidenced a shift in her concerns. At this point in the semester, collaborative planning of inquiry lessons begins. Students in the class were divided into groups according to their field placement, and are poised to begin brainstorming about lessons. Negotiation has already taken place as to the topic of their lesson-negotiation with their cooperating teacher from their field placement.

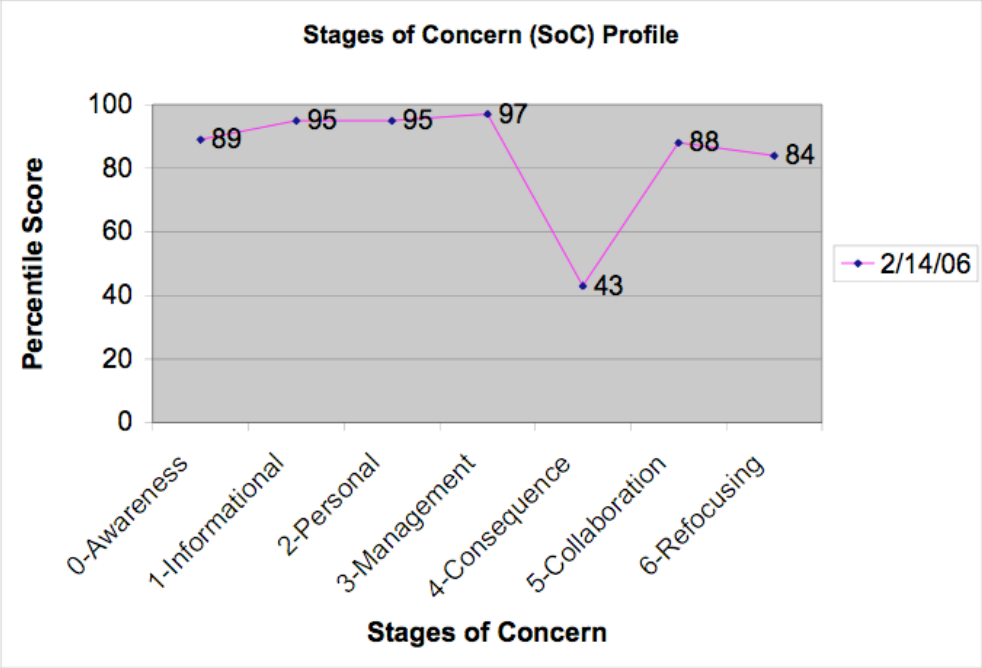


Figure 4.9: Lea's pre-collaborative planning, concerns profile

Lea still has evidence of a neophyte (non-user) concerns profile indicating that she is interested in learning about planning inquiry lessons; however, her initial single-peak informational profile has become a multi-peak concerns profile. Dividing the profile up into three sections, Self, Task, and Impact, the profile may be condensed from the previous discussion of Rebecca's profile, and interpreted as follows:

Within the Self category, Lea is interested in learning about planning and teaching inquiry lessons. She still has intense Informational and Personal concerns; however, of interest is the highest peak intensity of the profile in the Task category. This corresponds to Lea's concerns about management during her lesson. Indeed, of the group of three that

Lea is currently planning with, Lea will be the first to teach her lesson. Thus, negotiation and collaboration amongst her colleagues to plan an inquiry lesson contributes to a marked increase in Impact concerns, mainly, in stage 5. Stage 6, Refocusing may also be interpreted with additional background information. Of her group members, Lea is probably the most soft-spoken; thus, she is individually negotiating understanding between the different (albeit traditional) teaching beliefs of her colleagues, but not through discussion. Rebecca, our first case, was supposed to teach her lesson second, but ended up changing with the third colleague (not discussed in this paper).

Triangulating Lea's concerns profile with her open-ended concern statements (Table 4.11), indicate that her concerns have indeed shifted, as evidenced by the increase in management concerns, yet, Lea's core concerns have not changed. She still holds

Date	SoCq	Open-ended concerns statement
2/14/2006	2	I am concerned that my teaching [with a] constructivist method will not be effective. I am afraid that I am not going to do a good job, but I just learned about it and this is why I feel unsure right now.
	2	I would love to teach students in a constructivist manner, but I feel that my school, like every other school, will put too much pressure to "teach the TAKS" (Texas Assessment of Knowledge and Skills) and I will not be able to teach what I want to teach.
	2	I am concerned that some students will not enjoy the constructivist approach, and will only want to stick with the traditional approach. I do plan to balance both teaching methods, but I hope students are more open to the constructivist approach.

Table 4.11: Lea's open-ended statements of concern prior to collaborative planning

intense personal concerns about teaching inquiry, yet, she still holds her personal concerns much more strongly, suggesting that there is something else acting to activate her Task concerns. Indeed, since a major reduction in Self concerns is not accompanying an increase in Task concerns, Fuller's (Fuller, 1969) developmental progression cannot be used to explain Lea's changing concerns. Indeed, since Lea has had minimal

experience with constructing inquiry lessons, there should not be a decrease in Self concerns. Yet, since there is an increase in the intensity of Task concerns, something else must be driving the change. If Lea were to make a choice on what to focus on in her university course, based upon her concerns profile, she would likely choose to experience many more inquiry lessons, and reflect on her experiences as a student within the context of those lessons, with reflection as to the role of the teacher afterward. Hence, like Rebecca, above, the looming assignment of enacting an inquiry lesson in an authentic context seems to have a major impact on her concerns, and by inference, what she most attends to as she enters into the collaborative planning stage of Lesson Study.

Pre-Lesson Study Episodes

After several weeks of intense, collaborative planning with her colleagues and instructor, Lea's concerns profile (Figure 4.10) has not changed appreciably.

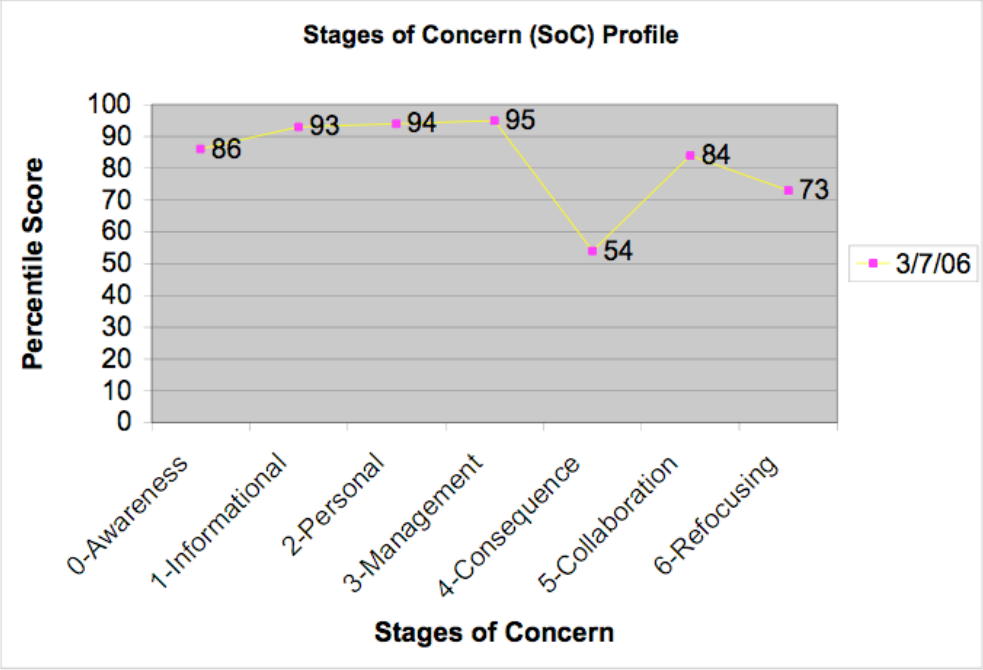


Figure 4.10: Lea's concerns profile at the end of collaborative planning

Her initial Impact and Task concerns are high, resulting in a multi-peak Informational and Management concerns profile with a secondary peak noticed in the Collaboration concerns, and Refocusing concerns. Her open-ended statements of concern (Table 4.12) reflect an empathy for students, as well as a sincere personal concern for implementation. Since Lea will be teaching her lesson the following day, with Lesson Study protocol emphasizing observation by all group members, and data gathering explicitly tied to the goals set by the individual, group, and instructor. (The instructor set one overarching goal for all Lesson Study Episodes.) An expectation of Fuller (1969) and George and Hall's (1978; 1976) stage theory is that, with experience, an individual's concerns shift as she or he learns about, and gains experience in teaching. Since Lea has not yet had any experience in teaching, her Self concerns would not be expected to reduce in intensity. Indeed, since Fuller, Hall, and George ascribe change to occur over years of experience, one lesson should not cause a marked decrease in the intensity of Self concerns.

Date	SoCq	Open-ended Statement of Concern
2/28/2006	2 2	I am concerned about whether or not I can teach the constructivist approach in an effective manner. Because I haven't been exposed to it for that long, I am worried my skills aren't very effective.
	2	I am concerned about my students' reactions to the constructivist approach.
3/7/2006	2	I'm concerned that my lessons won't always be taught in a constructivist approach, even though this is my goal.
	(4) 2	I'm concerned that my students will not learn because of lack of my constructivist teaching skills.

Table 4.12: Lea's open-ended statements of concern

At this time in the semester, the second Teacher Beliefs Interview was given, and is included in Table 4.10, above. The reader will note that, according to Luft and Roehrig, Lea's traditional beliefs about teaching are shifting toward student-centered beliefs. Indeed, there are indicators within the statements that Lea makes that show that she is

engaging with the new material in her university course, as well as re-interpreting (or further developing) her teaching beliefs to come more in line with her beliefs about student understanding. While some of Lea's beliefs are stable (see, for example her beliefs about the role of the teacher, and her beliefs about student learning in science), some of her beliefs shift toward constructivist beliefs. Using Piaget's metaphor of structure, Lea is engaging the process of adaptation, within the context of teaching and student learning in science in elementary classrooms. Extending Piaget's metaphor of adaptation, accommodation of new information into an existing schema may be related to learning of new information (learning about teaching using a constructivist pedagogy) within a traditional framework of teaching. As Lea begins to make sense of this newly learned information, she begins to change her traditional schema of teaching, and re-structure the schema. This restructuring, this "sense-making" is evidenced by Lea's new connections between prior knowledge and new information, ultimately resulting in a gradual accommodation of this new knowledge through re-structuring her existing schema. At this time, however, Lea is still struggling to understand this new pedagogy, as evidenced by her open-ended concerns statements (Table 4.12).

Upon reflection on the similarities and differences between her first and second interview, Lea seems to be developing empathy for her students, at the very least appreciating the differing concerns and individual perspectives students hold.

> …I noticed that in my first TBI I did not mention anything on the environment I would create in my classroom. In my second TBI, I mentioned that I would attempt to create a comfortable atmosphere by making students feel at ease by welcoming any questions and thoughts/concerns. Before I started interning at my elementary school, I had not given much thought to the classroom environment because I figured it could be easily established. However, based on experience, I've realized that with so many different personalities in a classroom, it takes thought and planning to create a comfortable classroom environment. My cooperating teacher does a great job listening to every student's concern and makes sure to state rules so that everyone is on the same page. For example, when

> one student said something disrespectful to another student, my CT had a mini-lesson on how students should treat each other in a classroom (Lea_ME_3/28/2006).

Regarding the variety of individual perspectives, Lea describes

> …in my first TBI I did not mention anything about cooperative learning to maximize student learning, but in my second TBI, I stressed this idea. I've not realized that having students work cooperatively let students develop their social skills and gain more knowledge because of the wealth of information that is being shared in a group. When I am interning, I've had the opportunity to hear students conversations and how they work together (Lea_ME).

> She continues, "…my students work best when they are able to work cooperatively because of the wealth of information each student can provide. I feel that when students work together, it helps them feel more at ease than when students work alone because they have extra guidance that will eventually build a strong academic foundation. I am not going to get my students accustomed with working with someone else, but when the occasion arises, I want my students to make the best out of their cooperative work experience" (Lea_ME).

It seems as if her intern semester is a valuable experience. Additionally, Lea develops her inner voice, with respect to deciding what to teach and what not to teach.

> My responses in both TBIs were quite similar. In both TBIs, I mentioned seeking consent from the school principal, but in my second TBI, I felt more responsible to teach material that might be frowned upon. In my second TBI, my tone was more of "whatever is best for the students" will be taught. In my first TBI, I did not have an understanding of how the school system works, but now, I would most likely fight the system until a legitimate reason is given as to why a certain lesson should not be taught. I hate the idea of cheating my students out of a proper education.

A major change in Lea's conception of teaching science seems to have occurred since her first Interview. She identifies the major changes as

> "My answers differ a great deal…. [Initially] I would teach science by following the textbook. I cannot believe I actually wrote that. However, in my second TBI I wrote that I would teach science through the use of visuals, books, videos and field trips. I also made note that I would make connections on what we learn in class to the outside world. I now feel that it is very important to teach students that science is in their world outside the classroom. During my first science lesson, I made sure students could make a connection because if the student just

> receives information but cannot make connections, it is a waste of the student's time" (Lea_ME)

As evidence of restructuring indicative of accommodation, Lea describes the in-class projects "such as the electric circuits has helped me "relearn" what I once knew in high school. Through these activities I have realized that learning is a non stop process" (Lea_ME). She has also re-evaluated her initial conception of the utility of the Beliefs Interview. "At first I didn't think it was necessary to do the Teacher Belief [Interviews], but now I realize that it is a way to track my teacher learning progress." She moves on to reflect on her initial expectations for the course.

> "At the beginning of this course, I had no idea what to expect. I knew the course was named "Science Methods", so I figured we would learn more about the scientific method, but as I soon came to figure out, the scientific method is questionable. All in all, I expected to learn how to become an effective science teacher and I think I am on my way."

She continues,

> What has helped me become a better teacher is realizing that practice makes perfect. I was under the impression that if at first you don't succeed at giving a good lesson, things will only go downhill from there. However, I have moved past my pessimistic viewpoint, because an expert was once a beginner.

As Lea relates, there are substantial changes in progress that are not captured through the standard coding of the TBI, or through the Stages of Concern Inventory.

Post-Lesson Study Episodes

At the end of the semester, after three episodes of plan-teach-revise cycles with her colleagues Claudia (not discussed here), and Rebecca, Lea's concerns continue to exhibit an Extreme Response Tendency (Figure 4.11) in that her Self concerns continue to increase along with her Task concerns; however, of note are the continued increase in all Impact stages. One interpretation is that Lea lacks the willingness to differentiate among the prompts, and fails to read them carefully. However, her analysis during the

third segment of this course indicates otherwise. She has a solid understanding as to the nature and the type of learning that she is experiencing as she continues to strive to understand constructivist pedagogy.

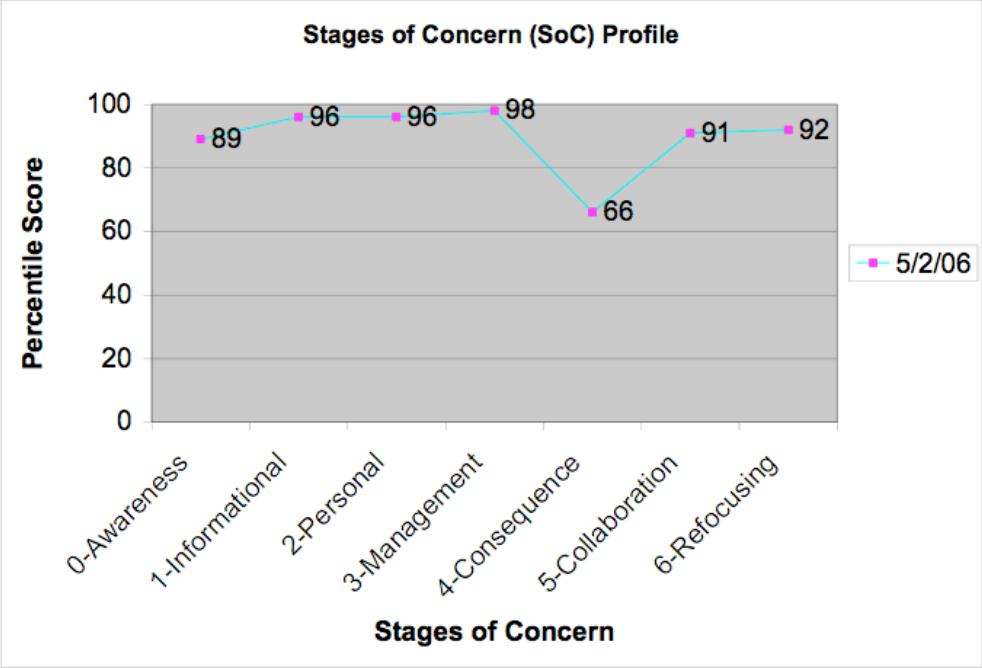


Figure 4.11: Lea's Post-Lesson Study concerns profile

Her open-ended statements of concern to register a shift from Self concerns, to Task concerns, concerns with the management of materials, with Self concerns still in evidence.

Date	SoCq	Open-ended Statements of Concern
5/2/2006	3	I'm concerned that I may not have as many materials as I'd like to teach my science class.
	2	I'm afraid [that] my "science" Spanish will not be well developed.
	2	I'm concerned that my students will be bored during my lessons.

Table 4.13: Lea's open-ended statements of concern

The trends continue, as Lea's beliefs shift more toward Student-Centered instruction (Table 4.10). In Lea's beliefs about deciding when to move on in her classroom, and how she decides what to teach and what not to teach, her realizations above seem to have impacted these (now) Transitional or Early Constructivist beliefs. In addition to her beliefs about teaching, her beliefs about student learning and understanding continue to shift, and indicate Lea's efforts to continue making connections between her prior conceptions and beliefs to new information. In the process, her prior schema is altered.

One additional point of discussion pertains to the formal definitions that Lea ascribes to. She defines Learning, and Understanding in the following ways: "Learning is the process of taking in information, analyzing it, and making sense of it" (Def_5/9/2006). Both [learning and understanding] are processes, with the learner at the center of the process. Understanding, which Lea defines as ability, "the ability to make sense of something" (Def), is something that "students possess." "Students possess an understanding of a subject when they are able to give an explanation on what they have understood." In other words, students must internalize new information, strive to make meaning of it, and explain it based upon their understanding." It is the explanation that is key for Lea. It is now the basis for her to move on in her classroom.

In sum, Lea's concerns, belief statements, explanations, and examples are in the process of shifting from Traditional instruction, toward Student-Centered instruction. These shifts have been triangulated with additional artifacts, and Lea's reflections. As we apply different lenses to help us understand how Lea is making sense of new information, and why her belief structures change, we gain additional insights into her understanding.

Epistemological Lens

With the use of an epistemological lens, the intent is to seek inferences of Lea's existing epistemological commitments (Posner et al., 1982), which are her fundamental understandings of teaching, the role of the teacher, and student learning in science. Also with an epistemological lens it is important to seek understanding of Lea's orientation toward knowing based on authority, as this seems to drive her sense-making of new material. A specific distinction, does she ascribe her orientation toward knowing to an external (absolute) authority, or does she see herself as an authority who is able to evaluate claims and assertions based upon evidence, is an important distinction. This distinction is a key element in teacher education, when seeking to understand how student make sense of new information and negotiate new beliefs (in light of existing beliefs). Using Green's metaphor (Table 4.7), and schemes by Perry (1970) or Belenky et al (1986), we are able to infer specific information about Lea's belief structure.

First, however, it is important to understand whether Lea has evidentially-held or non-evidentially held beliefs. As we have seen above, in interviews, Lea seeks evidence of student learning that is based on something her students do, or say, or produce. Even though she is developing these specific ideas over the semester (central to her beliefs about student learning in science), it is clear that she holds her beliefs based on evidence. Evidence, for Lea, comes in many forms based on her observations. One example:

> The biggest change that occurred with my thinking about teaching had to deal with classroom management. For some strange reason, I always thought that classroom management would be the least of my concerns, however, I've realized that classroom management is a major deal in a classroom environment. I realized this during my first lesson. I realized that I was having difficulty keeping the attention of my students because they were doing something else, so for my next lesson, I hade sure that my students had a visual to focus on. Also, while I was observing my partners teach, I noticed that one of them had the rules written out so the students could follow them and not be off task. I realized that his was such a great idea because this would save the teacher so much time from re-explaining

> to each student what he or she is supposed to do. So, I now know to write down the rules on a poster board so students can have a guide. (Lea_FRQ_5/10/2006)

Thus, through observation Lea seeks to change her perceived problems or weaknesses in her teaching.

In addition to the methods suggested by Green (1971) for determining the quasi-logical structure of beliefs, is one that is useful in Lea's case. It is the use of concept map techniques as a tool to produce a visual representation of Lea's logically primary and logically derivative beliefs. It provides a sense of what she considers as evidence for derivative beliefs. The following discussion about concept map use as a research tool was initially presented in paper form at the annual conference of the Association for Science Teacher Education[5]. Green (1971) seeks to determine whether beliefs are held in a quasi-logical relationship. The method of determination is based on participant interviews, and reasoning. If a participant uses one belief to explain another, then this may be considered to be a logically primary belief with respect to the other. If the belief is used as a fundamental explanation, it can be considered to be the logically primary belief in that part of a person's belief structure. In order to visually determine quasi-logical order, concept map techniques were used as a tool to construct visual representations (henceforth called "maps"), and constructed by the researcher from Lea's interview.

Specific to the map construction protocol (B. Fortney & J. P. Barufaldi, 2008), the maps may be compared in two ways. First, the *structure* of the maps may be compared. Second, the *content* of each map may be compared to each other, as well as compared with additional artifacts to further explore the nature of Lea's beliefs, and provide insights with respect to the beliefs Lea held as she entered into the PDS.

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[5] The paper presented at the annual conference of the Association for Science Teacher Education, St. Louis, Missouri, January 10, 2008, was originally entitled: Evaluating Change in Pre-service Teacher Beliefs through Differential Cognitive Maps, but re-titled as: Evaluating Change in Pre-service Teacher Beliefs through Visual Representations.

Once data were collected, transcribed, and member checked, three initial concept maps were constructed from the Teacher Beliefs Interview corresponding to the baseline, pre-Lesson Study, and post-Lesson Study segments of the main study. Each concept map was based on formal, semi-structured interviews (probing questions varied by participant) and self-report data (including asynchronous typed questionnaires), concept maps were constructed similar to the procedure by Fellows (1994). Fellows employed similar procedures to those utilized by (Chi, Glaser, & Rees, 1982), in that concept maps were constructed from participant verbal and written statements. Data were collected, and segmented according the procedure utilized by Chi (1997) into "proposition-sized units" (p. 285). Each proposition-sized unit was numbered to indicate contiguity, and indicate additional data for robustness.

Next, as Green's (1971) three dimensions of belief systems are used to infer the general structure of preservice teacher beliefs, the first dimension provides an idea for how the beliefs are related to one another in the belief system. First, belief systems have a quasi-logical structure, with some primary beliefs and some derivative beliefs. Primary beliefs are beliefs that are centrally located within the belief system, and are represented within a concept map at the top, because it is one of the first substantial utterances from the participant, or it is the most referenced within the map. (The following example is from the second interview, and chosen as it is a better example than the first interview.) For example, Lea states:

> (II.4) Interviewer: So let's think about your classroom, as you're thinking about it now. If that makes sense – with your students. **How would you describe your role as a teacher, in your classroom?**
>
> (II.4.1a) Lea: Uhm… let's see. I guess I'd be their fountain of knowledge. [Unintelligible few words]

(II.4.2) Lea: I don't want to be the person who will be able to explain everything to them. Like-

(II.5) Interviewer: Do or don't?

(II.5.1) Lea: Who *will* be able to explain it – everything to them. [spoken emphasis]

(II.5.2) Lea: Uhm, uh that they will be able to trust in me- like – trust my uhm- like consider me as knowledgeable in the subject. Uhm…

(II.5.3) Lea: I don't know [long pause] see my role as the teacher?

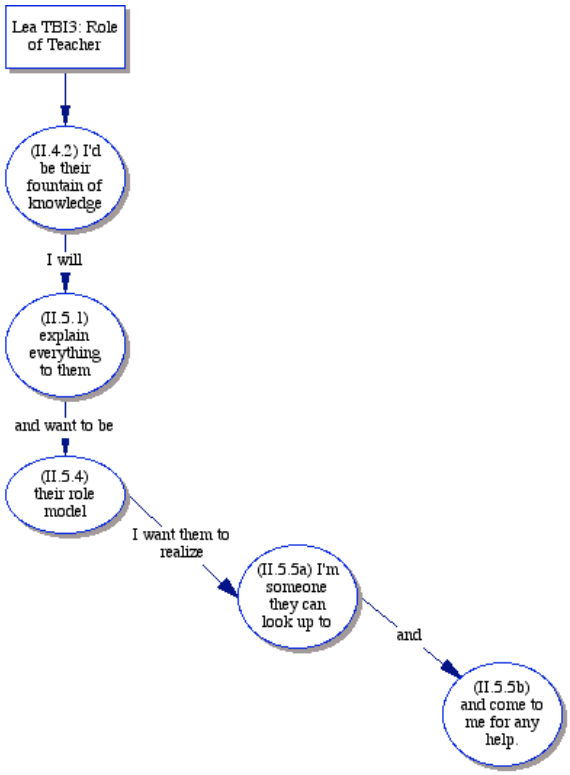
(II.5.4) Lea: I guess I want to be their role model as well.

(II.5.5a) Lea: Like I want them uhm… to be able to realize that I'm someone they can look up to and just (II.5.5b) come to me for any help that they need. [Laughing]

(II.5.6) Lea: That's all I can think about right now. (Lea_TBI3)

Generally, when a participant is being interviewed, the first substantial verbalizations are assumed to be the primary beliefs, with additional verbalizations and utterances taken to be derivative beliefs. This is best seen by an example from Lea's third interview. In Lea's answer, "I'd be their fountain of knowledge" is taken to be her primary belief because that utterance is made first. Too, as seen below, "fountain of knowledge" is placed at the top of the concept map because it is the first utterance, and assumed to be the primary belief statement. The number of connections that follow from each bubble reinforces this primary designation. Since, in this case, all bubbles have one link leading toward and away with the exception of Lea's first statement, the first statement is taken to be a statement representing her primary belief about the role of the teacher. Indeed, additional artifacts, such as observations of Lea's teaching, debrief, and lesson-planning meetings reinforce this designation. Further, the remainder of her statement: "[I] want to be their role model" is a derivative belief statement, as it derives from the primary belief statement.

Figure 4.12: Example of primary vs. derivative belief statements



Regarding the notation used in this protocol, each formal interview question was first assigned a Roman numeral indicating the formal protocol (in a manner similar to (Irez, 2006)), with the next numeral designating the question number for probing, and the last number indicating Lea's response unit. "II.2.1" indicates protocol question #2, interviewer question #2 (a probing question beyond the initial interview question), and Lea's first response unit.

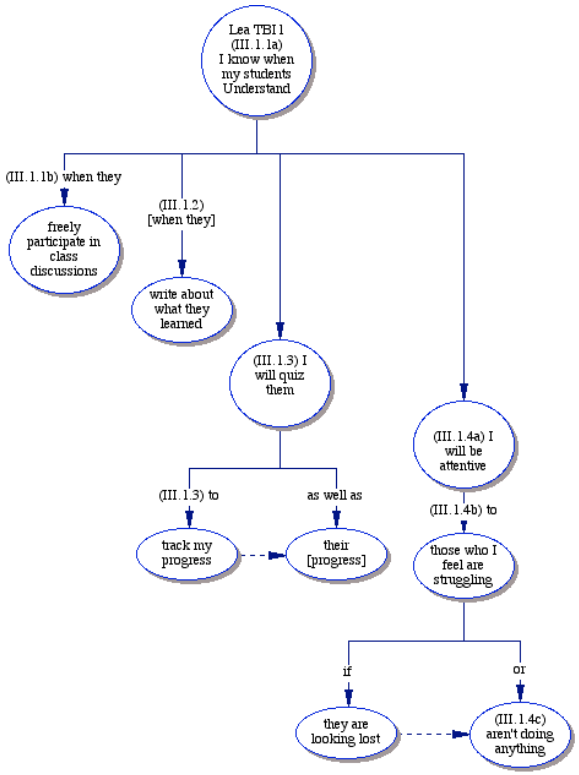
> Interviewer: (III.1) How do you know when your students understand?
>
> Lea: (III.1.1a) I will know when my students understand when they (III.1.1b) freely participate in class discussions.
>
> Lea: (III.1.2) I will also have them write about what they learned.

Lea: (III.1.3) Also, I will quiz them to track my progress as well as theirs.

Lea: (III.1.4a) I'll also be attentive to (III.1.4b) those who I feel are struggling if they are looking lost, or (III.1.4c) aren't doing anything.

Once segmented, contiguous segments were translated into maps in that the first response/segment was placed at the top, with additional segments and responses added below. Any segment that consisted of multiple units is depicted by a progression of circles from left to right on the map. Linking words came directly from Lea's responses. Because of this convention, maps may be evaluated on both structure and content of each map.

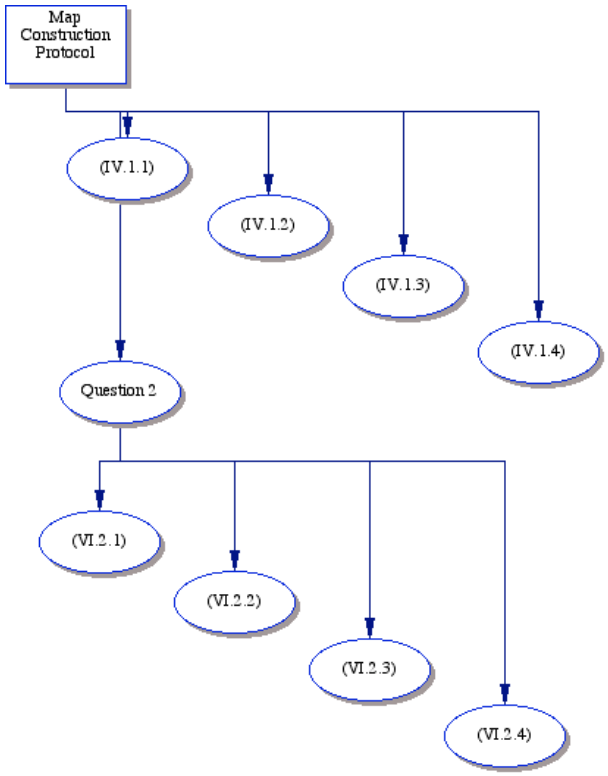
Figure 4.13: Example of map construction



In general, the concept map construction protocol can be represented as seen in the next diagram. In sum, the Roman number, IV represents the formal, semi-structured

interview protocol question. Next, the numeral is the question number indicating probing questions. Finally, the last digit represents the segment number with the convention “a”, “b”, “c”... indicating a segment that has been subdivided by content.

Figure 4.14: General example of map construction protocol



Recalling Lea’s prior experiences, she brings a common set of experiences with her to the elementary methods course that consist of: (a) minimal experiences in teaching science to elementary students, (b) “passive” experiences in science-both as an elementary student and as a university student, and (c) neither experiences in the teaching of science (at any level), nor experiences with decisions and planning that occur “behind the scenes.”

Once the interviews were conducted, they were transcribed by the researcher, and member-checked. Any asynchronous (email) interviews went through several

"clarification" iterations in which the researcher sent clarifying questions, and Lea returned the document with explanations that were indicated via "track changes" capabilities of word processing software. The following are a subset of the transcriptions, asynchronous interviews, and corresponding maps constructed with the above protocol beginning with her initial interview.

> Interviewer: (II.1) How do you describe your role as a teacher?
>
> Lea: (II.1.1a) I would describe my role as a teacher as being someone who cares deeply about their students [sic] progress, and (II.1.1b) who is a strong facilitator of learning.
>
> Interviewer: (II.2) How would you facilitate learning?
>
> Lea: (II.2.2a) I would facilitate learning by having guest speakers talk about the subject, and (II.2.2b) I would also love to take my students on field trips.
>
> Lea: (II.1.2a) My role is to be an effective and fun, engaging teacher, and to (II.1.2b) make the best out of each day.
>
> Interviewer: (II.3) How would you be an effective and fun, engaging teacher?
>
> Lea: (II.3.1) I would be fun and engaging for the students by dressing up. For example, instead of boring kids with just having them do book work, I will conduct experiments, and do interesting things.
>
> Lea: (II.1.3a) When I become a teacher, I plan on dressing up as a scientist and (II.1.3b) have my kids wear lab coats while (II.1.3c) learning about science.

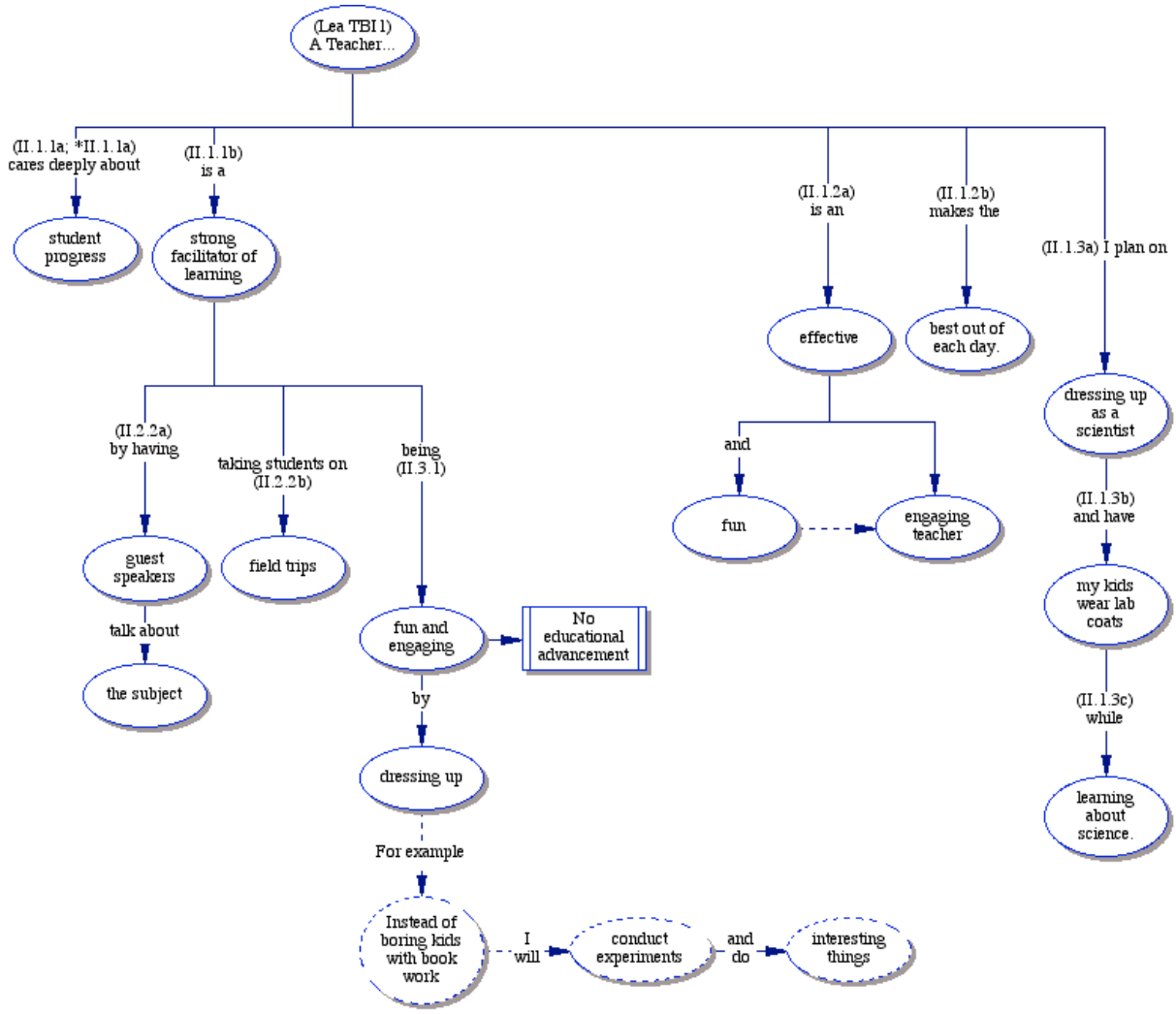


Figure 4.15: Baseline map representing Lea's prior conceptions of the role of a teacher

Second Interview

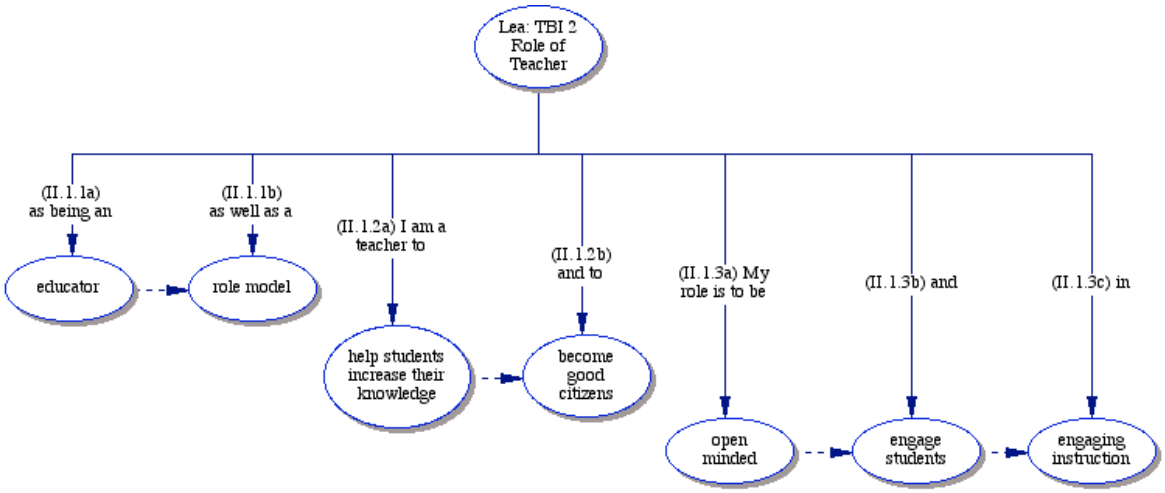
Interviewer: (II.1) How do you describe your role as a teacher?

Lea: (II.1.1a) I describe my role as a teacher as being an educator as well as (II.1.1b) a role model.

Lea: (II.1.2a) I am a teacher to help students increase their knowledge and to (II.1.2b) become good citizens.

Lea: (II.1.3a) My role as a teacher is to be open minded and (II.1.3b) engage students (II.1.3c) in engaging instruction.

Figure 4.16: Map representing Lea's conceptions of the role of a teacher from the second interview



Final Interview

Interviewer: How would you describe your role as a teacher, in your classroom?

(II.4.1a) Lea: Uhm… let's see. I guess I'd be their fountain of knowledge. [Unintelligible few words]

(II.4.2) Lea: I don't want to be the person who will be able to explain everything to them. Like-

(II.5) Interviewer: Do or don't?

(II.5.1) Lea: Who *will* be able to explain it – everything to them. [spoken emphasis]

(II.5.2) Lea: Uhm, uh that they will be able to trust in me- like – trust my uhm- like consider me as knowledgeable in the subject. Uhm…

(II.5.3) Lea: I don't know [long pause] see my role as the teacher?

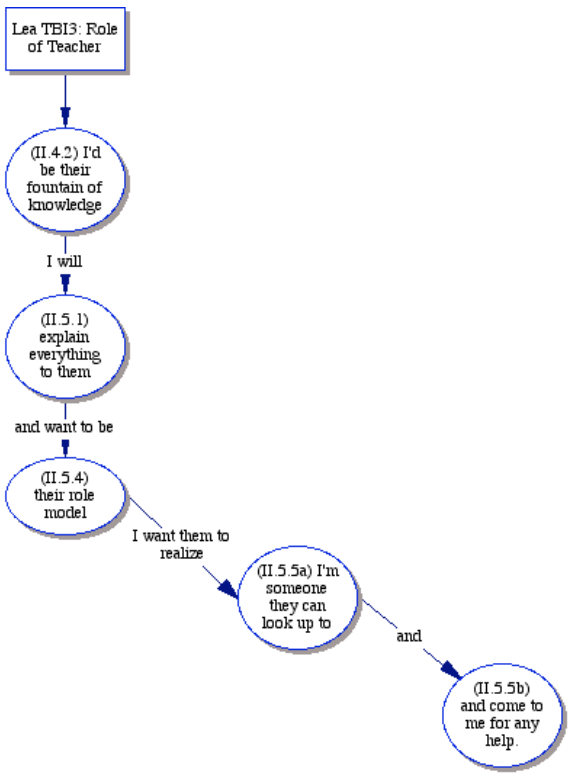
(II.5.4) Lea: I guess I want to be their role model as well.

(II.5.5a) Lea: Like I want them uhm… to be able to realize that I'm someone they can look up to and just (II.5.5b) come to me for any help that they need. [Laughing]

(II.5.6) Lea: That's all I can think about right now.

(Lea, TBI3)

Figure 4.17: Map representing Lea's conceptions of the role of a teacher from her final interview



Lea's conception of the role of the teacher seems to change from her initial conceptions, as shown by progressive change in structure and content of the three maps. As indicated by interview transcripts, her conception of the role of the teacher is slowly reduced to a primary belief: The teacher is the fountain of knowledge in the classroom. This belief was likely founded early in Lea's education, and reinforced over the fourteen consecutive years of education. Even though her university coursework (Science Methods and Social Studies Methods) had engaging activities that challenged Lea to actively construct a different understanding of the role of the teacher, her beliefs about the role of the teacher seems more impacted by her internship in an elementary classroom, her classroom teacher, and her prior beliefs about teaching and student learning in science, than her coursework over the semester.

Referring to the structure of Lea's maps, they progressively became simpler in structure and connections, and eventually lose any branching to become linear. The image of a teacher and beliefs about the role of the teacher that Lea brings to the program goes through changes with respect to her primary and derivative beliefs.

Referring to the content of Lea's maps, when interviewed, Lea had some specific points to make regarding changes, and the reasons for the change. The important changes in content from the initial map to the second map that Lea notes:

> In my first TBI, I wrote that my role as a teacher was to be an educator who cares deeply about my students' progress. However, in my second TBI, I mentioned being a caring educator, but I also mentioned my role as a teacher as being a role model. (Lea_MTX)

She reasons:

> Since I have started interning [a requirement of the PDS in the first semester], I have realized that students watch your every move, and make you their role model. For example, my coordinating teacher never raises her voice, and the students in her class don't either. I feel that when they observe Ms. P being calm

> and respectful, they try to behave that way too because that has become the classroom norm. (Lea_MTX)
>
> I feel like the students think in a way where if the teacher does something, it is considered okay for the students to do it. For example, if a teacher were to always raise her/his voice, I feel the students would always be raising their voices. (Lea_MTX)

Her coordinating teacher, Ms. P, approaches science instruction in a very methodical way, with detailed plans, and has a theme of respect that cuts across all subjects.

In Lea's case, a major factor that impacts her conceptions about the role of the teacher is the authentic context of the classroom environment. This can also be seen by the changing concerns in her Stages of Concern profile (Figures 4.8 to 4.11). Lea continues her analysis:

> Also, in both TBI's I mentioned being an engaging [teacher] as one of my roles because if the teacher cannot hold their student's attention, then there can be no educational advancement. (Lea_MTX)

Indeed, her internship in an authentic context had a major impact on her thinking about teaching science, and the role of the teacher. Lea continues:

> However, I did not mention being open-minded in my first TBI, and in the second one I did. I've learned that student's ideas can be on both extremes, and to keep an open mind teaches students to do the same. I feel that if the teacher creates a role for herself as being open to anything, the students will do the same (but only if the teacher explicitly states and reminds her students of her beliefs). (Lea_MTX)

Her reference hints of the instruction Lea received in her university coursework (Elementary Science Methods and Social Studies Methods courses), and teaching experiences that her instructors continually explained reasons, and his thinking behind the decisions made in the course, as well as methodically discussed and engaged Lea (and colleagues) in brainstorming and discussing the reasoning and rationale for use and placement of specific lessons and assessments; however, the major impact on Lea's

beliefs, and the complexity still reflect her authentic experiences with her coordinating teacher, Ms. P.

The content in Lea's final map fits securely into the traditional teaching category, as coded via informational maps (J. Luft & Roehrig, 2005; Roehrig & Luft, 2006) and has lost all branches, and examples. It is important to note that the interview took place at the end of the semester, before final exams before final projects had been submitted; however, the change in Lea's final map is notable, yet Lea was not any different during her interview (albeit a little more tired) than she was during her previous two.

One possible scenario for the simplification of Lea's concept map was mentioned above-the impact of a traditional cooperating teacher for her first internship hours. Combined with Lea's own words that she doesn't "really remember actually, being there" (Lea_TBI3) in her elementary science experiences. Lea's statement leads to another scenario that may be plausible. It is that preservice teacher memories of elementary school science when they were students is hazy

In Lea's case, she is beginning to activate her prior knowledge, separate concepts from feelings, identify key memories, and beginning to formulate answers that represent her conceptions-which by her own words is not easy. On several occasions she prefaced her answer with "I don't know" and began to work out her answer in a thoughtful manner. By the end of the semester, the structure of Lea's belief about the role of the teacher was reduced to a primary belief, which then might be further challenged in the second semester of the PDS. Lea also might benefit from a non-traditional cooperating teacher. Lea's prior experiences have been exposed for consideration and evaluation with respect to evidence produced in authentic contexts, and Lea realizes that she still does not have answers to some questions that she entered the course with.

> You know…I guess I don't really know how to keep a student's interest. Like, what- what would I do that they wouldn't start losing interest, in this subject? [short pause] I don't know. [long pause] I think that, uhm… I have to make the… ultimate… lesson plans, they just- like made for certain students who are a little more advanced and, like those who need extra help to… [short pause] hm. I just- I just- I mean I just want to keep their interest, you know, in the subject. Because- I don't want to lose that. (Lea_TBI3)

According to Green's metaphor, the second part deals with beliefs being psychologically centrally located within a belief structure, with psychologically centrally located beliefs characterized as strongly held. In Lea's case, it is difficult to infer which of her beliefs are psychologically central, whereas in Rebecca's case this was inferred through repetition. For Lea, her beliefs are progressing steadily, and can be characterized as progressing with "quiet introspection," in which Green's quasi-logical structure take precedence over the strength in which in her beliefs are held within her belief structure. At the end of the semester, Lea does seem have clustered beliefs, in that her beliefs about student learning in science (as coded in the Teacher Beliefs Interview) are not well connected to her beliefs about the role of the teacher.

Returning to Posner et al (1982) assertion, "learning is fundamentally coming to comprehend and accept ideas because they are seen as intelligible and rational" (p. 212) and that, based on evidence and their perceptions of the evidence, students make judgments, Lea's learning trajectory of quiet introspection, seems to indicate that, when dissatisfaction occurs for Lea, she is finding the new conceptions intelligible and plausible in that she engages with her dissatisfaction, and strives to make sense of things that seem to contradict her understanding.

Expectational Lens

This lens provides a perspective that gives insight into Lea's expectations of teaching, and expectations for student learning. For Lea, since she exhibits quiet

introspection of her initial beliefs and conceptions as a result of observations and new experiences, has verbalized the change in her expectations. For example, from her interviews, we have seen her relate learning to being open-minded to student ideas, which she attributes to learning from her classroom teacher. Indeed, she also describes keeping student attention through the addition of a focal point, or visual for students to look at during her lesson, and setting the classroom norm through example. Both of these examples were prefaced with statements such as "I noticed that this was different than I expected" or "I realized that I had a difficulty keeping student attention during my lesson that my partner did not." Her expectations are evolving based on new experiences, and introspection.

There are apparent differing expectations, in Lea's belief structure, as evidenced by her differing beliefs about teaching and beliefs about student learning, as coded in her Teacher Beliefs profile. These may be seen in the interview excerpts used in the discussion surrounding Table 4.10. For Lea, there is not as much tension in evidence as in Rebecca's interview, as Rebecca sees science as a direct contradiction to the bible, whereas Lea does not.

Social/Affect Lens

As mentioned in the discussion about Lea's concerns profile, the concerns she attends to shift as the semester progresses. This is well triangulated with the open-ended statements of concern as well as triangulated with the reflections that Lea wrote throughout the semester, and her final reflection from the semester.

THE CASE OF JENELLE-INITIAL BELIEFS

Jenelle enters into the course as an Intern II, with no formal experience teaching at any level, and only her personal experiences from her own schooling forming the basis

of her beliefs about teaching and student learning in science. She has, in her previous semester, some observational experience in authentic classrooms, which she estimates as 30% of her time from one course. Added to these observational experiences are her informal (private) tutoring experience, and teaching Sunday school. She classifies herself as a non-user, or neophyte when it comes to teaching science at the elementary level, and her personal goal for the semester, “I wish to have a thorough knowledge of science and different methods to teach the course. Also, it would be great to have ideas on projects, activities, or experiments to do with children” (Jenelle_ICG). When she thinks about teaching science to children, her initial concern is for “being able to get and retain their attention,” and “giving information out clearly.”

Jenelle elaborates on her previous field placement, and describes it as

> [00:09:15.06] Jenelle: TAKS preparation. This whole entire year has been like, AH! [Whispered] We don't get observation time because we're like, separated into centers, and, all we do is like, get packets like that are fifteen pages long and they read, and they answer questions. They read and they answer questions. I'm like, "oh go on, kill me." [Whispered] So, I imagine if onboard to Hell [sic], like, I don't know how the students are going to feel. So.
>
> [00:09:32.24] Instructor: Yeah, did they take it pretty well?
>
> [00:09:35.19] Jenelle: But they do it every day, so, even though it's long, it's kind of like, you know, a weekly packet or something. So they get like, a couple of pages each day. But the thing is like, each day, an hour and a half of rotations, she does reading and answering questions. That's just, not, good. [Whole sentence stressed] And then you can tell, because, you have students that, they're just like, not focusing, and the groups were made so poorly that, like, I-I think she kind of rounded them out on the level, of like, "Oh you speak Spanish." "You speak more English." "You speak...both." But then, she really didn't like-she couldn't even separate even more as in like, "you're higher level, you're lower level." So you have students that read really fast, and then you have students that get lost, and then, all of a sudden they are just looking at the ceiling, and then, they lost-they couldn't keep up at the beginning, and they lost all this-and because they were just doing something else. So, even between like a small group of five people, you have two students who are like, SO much ahead of you, and then the other students are like, "oh my god, where have you been for the past, like, half an

> hour?" So it is, pretty frustrating at the beginning. But then, if you, you started knowing like, you kind of like, you, you kind of know better, like, this student needs more attention. This student needs to, work with a partner to slow down and stuff like that. So you kind of like, you know, you work around it. But, AHHH! at the beginning, I was like "Oh what is wrong with this student?" Like, is she really not doing it? Or she doesn't understand this, or is it the language problem, or whatever. But I guess, like, over time [emphasis], everything kind of like, you know, falls into, like it's own place.

Thus, her field placement seems to reinforce her previous experiences in education, and create an annoyance in that Jenelle still has not taught a lesson. At this time, her experiences as a student (seeing education from a student perspective) lacks any field experience designed to introduce education from a teacher's perspective. Thus, when Jenelle begins to learn about, and plan for instruction of an inquiry lesson, she does not have similar experiences that her colleagues have had. Her image of teaching still lacks any insights into the teacher's perspective, for example, decisions made by teachers, the weighing of possible ideas or avenues of approach to take in given situations, and her image of teaching is missing the importance of prediction of possible student answers during lesson planning. All of this is normally hidden from students during lessons.

To Jenelle, when she conceptualizes teaching science to young children, she describes teaching as composed of the following characteristics. Initially in her Student Inventory about Science, "learning about nature through textbooks" hints at a common theme for Jenelle, one that is solidly grounded in her own experiences in classrooms. To her, experiments are hands-on/minds-on activities in science "in which students can actually learn about textbook materials." Beyond this, Jenelle does not elaborate. Next, she includes hands-on projects, field trips, and experiments—all without examples; however, she consistently mentions them throughout the semester. To Jenelle, science should be fun, with these activities, as well as "adopting animals and learning about

them" all hinting at her conception of science at the elementary level. One interesting note is the final notation on her diagram, "making connections between the lesson and their [students] own lives" is important to Jenelle; however, she never comes to a solid explanation of what she means by "connections" during the semester. Indeed, a teacher's perspective is missing.

Regarding science, Jenelle defines inquiry with two words, "to ask?" and a scientist as "a person who specializes on science subjects, [and] learn by discovery." Indeed, matching this emerging conception is her Draw A Scientist Activity (Chambers, 1983; Farland & McComas, 2007). She depicts a sensationalized appearance of a scientist, a woman with a lab coat, frizzy hair, and goggles holding a fizzing beaker. The location is a sensationalized lab, primarily due to her depiction of smoking test tubes, fizzing and bubbling beakers. Also included are a microscope, and a computer with mathematical equations written on the screen. Her caption:

> I drew a woman scientist with dorky glasses and with a test tube in her hands. She is experimenting with different things and saving that information on the computer. She has her own laboratory—with a microscope, computer, and test tubes and weird mixes. (Jenelle_SIS)

Coding of Jenelle's interviews reveal an image of a teacher who is fun, and who should make teaching "memorable" (Jenelle_TBI1). There is no apparent tension like her colleague, Rebecca, who experiences, and recognizes tension between an ideal image and her (Rebecca's) comparison of herself with her ideal image. Jenelle's tension is different. It is hidden, and not explicitly held in her mind. Jenelle's tension resides in her perception. She only perceives situations from a student's point of view. Thus, her perception of her elementary students, and her perception of herself as a developing teacher are both from a student perspective. She has not started developing a conception of herself as a teacher, and experiences her university coursework through a different

lens. She seems to conceive of science lessons from the point of view of the student, grounded in her past experiences, and becomes frustrated when having to step into the role of a teacher as she plans and enacts an inquiry lesson. This can be seen in discussion regarding her concerns profile, below, indeed, it becomes a Crisis of Practice as she is forced to confront her planning for, and enactment of a lesson. Indeed, in her last interview, she seems to include many conversations that, when prompted, students will convey about teachers, and their teaching.

> [01:00:58.09] Instructor: Is there anything that I haven't asked that you want to, you know, that you want to add or is there anything that you want to add to this [intervew]?
>
> [01:01:09.03] Jenelle: I think, OK. I just think that even though I say that with a lot of whining, a lot of...[pause] you know...[long pause] It was, a really worth while experience. Like, it's excruciatingly like painful to go through the process, but once everything is kind of like, we always joke about it. It takes me three hours to make a half an hour lesson! But when, it's actually implemented, and the students actually get it, it's just, like, you have no words to explain that because....[trails off]
>
> [01:01:37.14] Instructor: You're talking about the process of us planning with the group, and then it's what? Fausto, Carrie, you and me-
>
> [01:01:42.08] Jenelle: Planning alone. Planning with a group. It doesn't matter how you plan it. Just the amount of time that [intake of breath] how are we going to engage the students? Ah let's see. Let's look for a fun but educational way. How are we going to do the inquiry? But we have to find the - uh - right information. The right material. And then explain. OK how can I explain it so it's not-boring as heck, and not as long? And then the elaboration. And what can we do to extend it. You know? And then, on top of it you actually have to go and find the material, and, see, all that is-what-uh-once you know, [unintelligible few words]. But like, once this is actually, once everything is together, it's really nice! [laughs] Is actually really nice to see it and, you know, it flows really nice when you don't have people breathing down your back, and you know? [pause] It's really-
>
> [01:02:21.25] Instructor: Was it easier, or harder, or just not, a problem that-to plan with a group?

> [01:02:27.13] Jenelle: Actually I like being where-Oh, well, there were down sides and good sides to it. [long pause] Incredible, like, how your ideas, and somebody's ideas are...towards the same topic, but they're so different. And you want to use both, but you can't and you want to mesh it but it's excruciatingly its-it's just too much! And then, but, it kind of gives you, you have to do something else. Maybe I can use this for something else. And, just having a part-a group like, you know the motivation to do that. And deadlines, come on. You know, deadlines to keep you on track. And procrastinators like me! Oh my God, that's-that's heaven to have like, pr-annoying but, that's good! Downsides, it's like, sometimes you are conscious of like, Oh my God, I'm bringing my whole group back, because of like, you know I'm not doing this as fast. Like, I-I just don't get it! [emph] You know? OR, you know, sometimes time, management, like, I know everybody has a lot of stuff to do. So….

Evidence for Jenelle's student perspective on lessons is seen in her discussion of her lessons. She views teaching and planning from a student perspective. She does not take the perspective of a preservice teacher learning about planning for, and enacting lessons. She does, however (see 01:01:42.08, above), use much terminology that she heard throughout the beginning of the semester. In this excerpt, Jenelle is attempting to describe the 5E (Bybee et al., 2006) lesson plan format, and has difficulty. It is the use of terms without a clear explanation, or some sort of explanation that is interrupted by another thought that indicates she has not understood the differences between the various stages of the 5E lesson plan format.

Jenelle enters into the semester with an initial concern, "being able to get and retain their attention," and "giving information out clearly." This is also seen in her initial concerns profile (Figure 4.18), which may be described as a non-user (inexperienced) concerns profile of someone who has ideas about teaching.

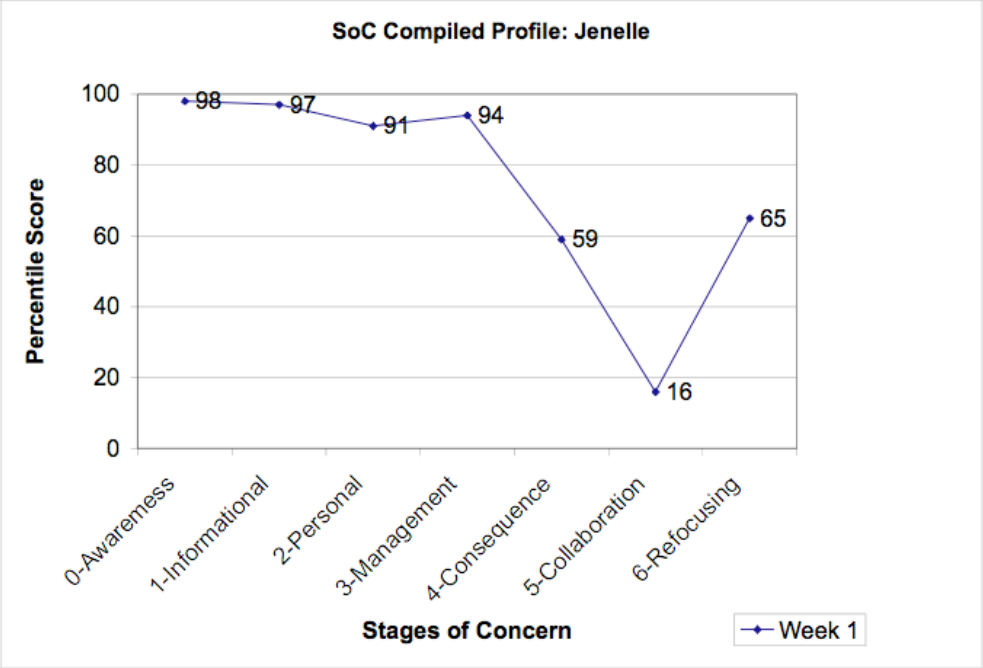


Figure 4.18: Jenelle's initial concerns profile

Of note, are her high Self concerns which include informational concerns about teaching science, and high concerns for personal demands, and her adequacy to meet the demands of teaching. These are triangulated with her open-ended concerns, and discussions within her interviews. An obvious indicator that there may be resistance, or at least ideas that compete or conflict with a different method for teaching science, can be seen with a major tailing-up between Stage 5 and Stage 6. Since this is accompanied with extremely high Informational and Personal concerns, it is something that needs to be addressed. Indeed, as George et al comment, profiles such as these in a non-user profile

should be taken as a warning (p. 42). Indeed, "a more severe tailing-up should be heeded as an alarm" (p. 42). Throughout the semester, this tailing-up is accompanied by a pronounced 1-2 (negative) split, and Jenelle's Crisis of Practice occurs during her teaching of her first lesson, and her subsequent debrief and re-planning sessions.

Pre-collaborative Planning

After the initial, intense, four-week instruction including inquiry lessons, and enacted examples of inquiry lessons, Jenelle's concerns profile (Figure 4.19) undergoes several changes. She now has a multi-peak management concerns profile with developing issues about teaching inquiry.

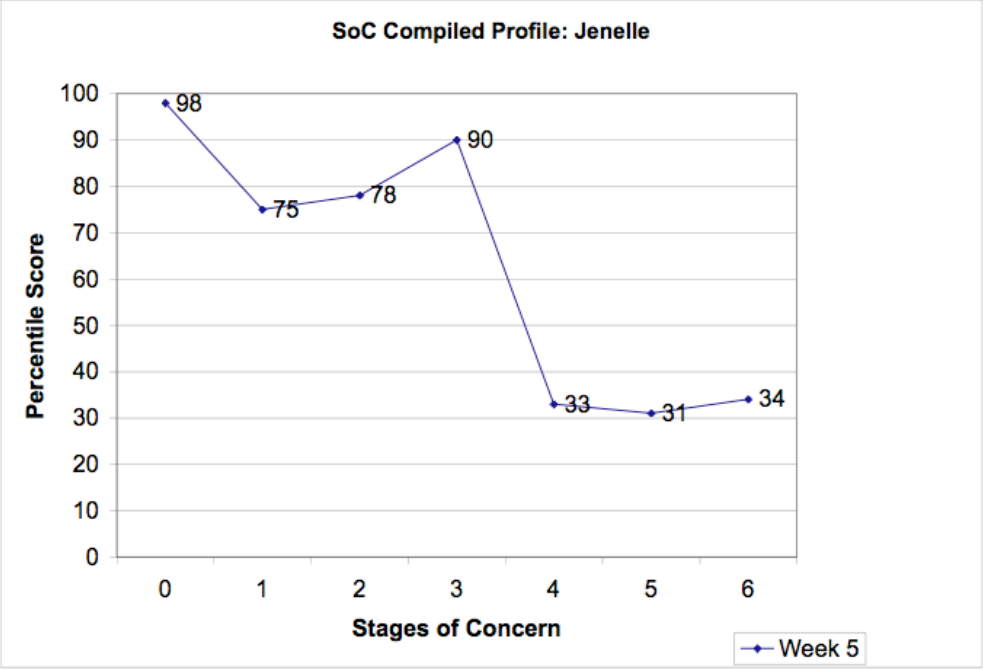


Figure 4.19: Jenelle's pre-collaborative concerns profile

There is a reduction in intensity regarding informational concerns about teaching an inquiry lesson, as well as a decrease in personal concerns about adequacy in enacting this

lesson. However, Jenelle's personal concerns are more intense than her informational concerns (a negative 1-2 split (George et al., 2006a, p. 40)), along with a tailing-up, which are now of major concern for her university instructor. As George et al caution, "an individual with this kind of profile probably will not be able to consider a proposed innovation objectively until his or her Personal Stage 2 concerns are reduced. In this situation, with no experiences to guide her, Jenelle cannot seem to reconcile her student perspective of an image of a teacher and episodic memories (Abelson, 1979) of science lessons, with what has been taught in her university course. As she looks forward to a few weeks of collaborative planning, she continues the path toward her Crisis of Practice, and has various degrees of doubt and potential resistance to teaching an inquiry lesson (George et al., 2006a, p. 40).

The second most intense concern evident in her profile is concerns for Management of materials and resources, which along with her relatively intense Personal concerns are also seen in her open-ended statements of concern, which are the concerns that she can verbalize.

Table 4.14: Jenelle's open-ended statements of concern

Date	SoCq	Open-ended concern statement
2/14/2006	2 2	I'm concerned about students not really discovering or learning anything on their own. What if I am not teaching the right [thing] or way or well, actually I don't prepare the class or activity well enough for them to learn on their own.

Pre-Lesson Study Episodes

Jenelle's developing resistance continues to build (Figure 4.20) as her profile exhibits drastic changes in her concerns, three days before she is scheduled to teach. Her two partners, Fausto and Carrie have already taught their lessons, and the entire group has

progressed through two previous Lesson Study cycles of plan, teach, revise, with Jenelle's to come.

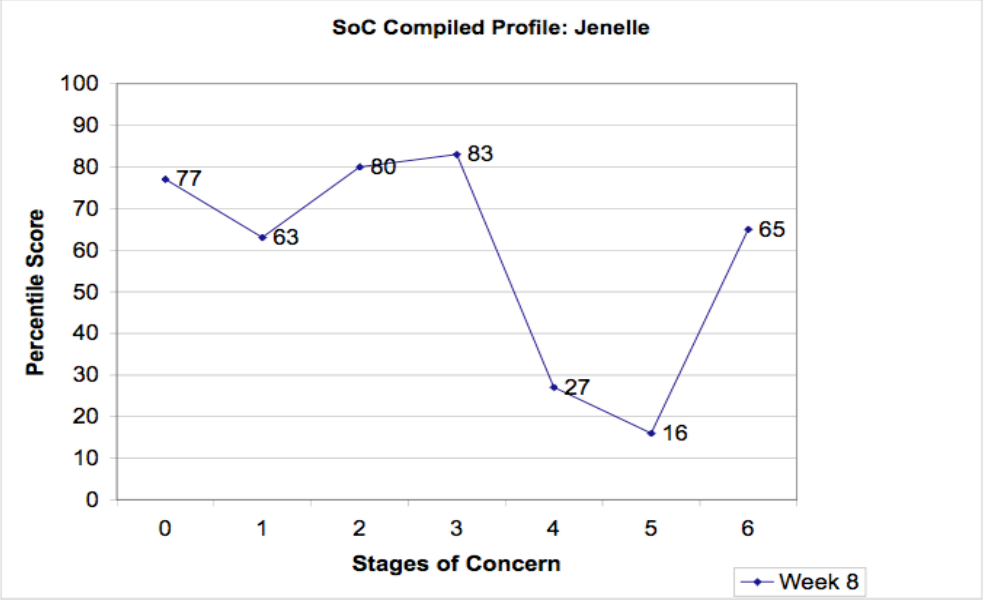


Figure 4.20: Pre-Lesson Study Episodes

Jenelle's profile is still a multi-peak management and concerns profile with developing degrees of doubt, yet, the intensity of her Stage 6 tailing-up and severity of the Stage 1-2 Split is shocking. She still has a primary intensity of management concerns, as she begins to fully comprehend the teaching task ahead of her. Her open-ended concerns (Table 4.15) from this time period, including the day before she teaches her lesson, capture her impending crisis of practice, which has been exacerbated by procrastination.

At the end of the semester, she reflects back on this point in time, which is excerpted above, at time code [01:02:27.13]. Part of what led up to her Crisis of Practice was her procrastination, and expectations that she can continue her role as a student, not accounting for the time it takes to plan lessons. She was present at all of the planning

meetings with Fausto, Carrie, and her instructor, and even had the group's attention for one, three to four hour block of collaborative planning. Too, she was present as first Fausto, then Carrie took charge to lead the collaborative planning session to plan the first two of a three, day, lesson.

Table 4.15: Jenelle's open-ended statements of concern

Date	SoCq	Open-ended statement of concern
2/28/2006	2 2	If students don't really understand or know what to do in the activities then I don't think they'll come out learning anything. So my worry could be that, "what if I don't set up the assignments effectively (correctly for them to work on their own)."
	2 2	Getting the students excited about the activities is one concern, but I think even worse is that students get bored with the lesson/completing the assignments, like the lesson is not going to be worth sitting through.
3/7/2006	N/A	My science lesson on Thursday! I'm having a nervous breakdown.
	N/A	My other classes-all the lessons I will have to prepare whether I have to teach or not. Just too much right now. Need a good class on time management.

JENELLE'S LESSON

Jenelle, guided by a few prompts, wrote the following in the day following her lesson, before the group met for the group reflection and final revision meeting. She reflects in a typed document, (excerpts)

> **1. What do you think went well? (Why? What evidence can you show for this?)**
> (Let me start by saying, OH MY GOSH! It was terrible all around. I just freaked out and I couldn't get my lesson together.)
>
> I think only the exploration part was not too bad. The students were observing the three different types of rocks and they had to tell me what they had observed, feel, see, smell, etc. Some of them gave me good ideas such as: the zebra pattern, the escalators/steps, that were part of what I had predicted and it lead on to the layers lesson, which by the way, I ran through and didn't write it down.
> (Jenelle_IR_Self)

2. What do you think needs improvement? (Why? What evidence can you show for this?)

> I think I need improvement in every sense. First of all, I was relying too much on what they had learned during Carrie's lesson, so I thought the engage part was going to run by smoothly. Then, during the actual engaging part-where the students were to give me characteristics of the rocks, they didn't really remember specifically which characteristic was for which type of rock, or my predictions didn't really mesh well with the actual answers. For some of the answers I was getting… I froze, and didn't even know where to write them down. In my head I was trying to map out specific characteristic that would clearly distinguish the rocks but evidently didn't work out so well. Maybe I just should have given them sedimentary and igneous rocks again for them to repeat briefly the chart characteristics. Then, we had the explanation part-where I was just running through it and didn't write anything down. I think I was speaking really fast all of a sudden and slowing down the next minute, I am not sure about the pace of my speech…not to mention the constant switching of English and Spanish. I just did it involuntarily but I would catch myself and I would try to go back to English. The only Spanish part was supposed to be the direct teaching moment, which was only like 30 seconds, when in reality I was supposed to take my time and write the definitions down. Also, during the play dough activity, I think I wasn't explaining myself very well since all students tried to get their own metamorphic rocks instead of working in partners. I should have just made different Ziploc bags with just three pieces of play dough and beads, to organize it better. Then, we had the next section-elaboration part: in which we were to get three different rocks and classify them either as sed, ig or meta, BUT…I had told the students to leave the play dough in the center of the table, and very tempted 4th graders were playing around with it when they should have been working on their new sets of rocks. Ultimately, I was rushing them all the time because I felt like we were falling behind and I felt awkward about the silent periods. (Jenelle_IR_Self)

Many of Jenelle's mistakes are common to preservice teachers. Time and, materials management, code switching, pacing, minimal wait-time, and minimal content knowledge required for the lesson at hand. However, given the lack of teaching experience that she experienced her first semester as an intern, she was not able to make connections to group discussions, reflection sessions, and lesson observations of her partners as Lea had. Upon completion of her lesson, and immediate debrief with her entire group, Jenelle was very brave, and to her credit, slowly related her fears and

thoughts. Later, during her written reflection, she compares her concerns prior to, and after observing her colleagues teach, and teaching herself.

> As I said it before, I always worried about people being engaged all the time and being able to be active during the engage section. I have to admit, after Carrie's lesson I was much relieved, but it didn't quite work out in mine. And when I thought about it, I remember that she had given them rocks to work with in the first place and therefore she had many more characteristics and most importantly, specific characteristics to write down on the table. I should have definitely given them at least one type of each rock to start with. Now, my anxiety of having another lesson with the inquiry format is back. It is so hard to predict correctly what students will come up with. Also, I didn't really think I was going to freak out "outwards". Yes, I start giggling and turning red when I usually teach, but I never freeze or start saying "OH, my.." in the middle of a lesson, but for some reason today, I just completely lost it. So, I wonder if from now on, this is something that I will have to worry about… Another thing was what if the lesson doesn't really flow from one section to another. I can't remember well if it did or it didn't, but personally I think everything was very choppy. Like when we finished the chart (seg/ig section) and I started talking about the metamorphic rocks. I think that between the filling of the chart and the direct teaching, there was something missing. Then again, I was so nervous that I didn't even remember to write them out.
>
> I cant remember for most of the parts, how exactly things went down because I was extremely nervous. I do realize I freaked out and it was very noticeable by everyone, even the students. I am so embarrassed and disappointed about how the lesson was carried out. Some students didn't get the classification correctly, there is definitely something that I was doing wrong. (Jenelle_IR_Self)

With this realization, Jenelle may be ready to reassess her traditional images of teaching; however, the semester is mostly over. She will not have much time to receive guidance, time, and planned experiences (such as Lesson Study) in her remaining time during the semester, or at the university (seven weeks). In her professional development sequence, she has yet to student teach, with (most likely) a majority of Cooperating Teachers ascribing to a traditional framework for teaching. Due to her previous semester, she has lost out on precious time in making connections between her prior experiences

and beliefs about teaching and student learning, and her new experiences and new information.

Post Lesson Study

After a very supportive group meeting, Jenelle and her partners met several times informally, and continued to work together on their final re-write of their lesson, and final reflections. At week 16, the very end of the semester, Jenelle's concerns profile has undergone change (Figure 4.21).

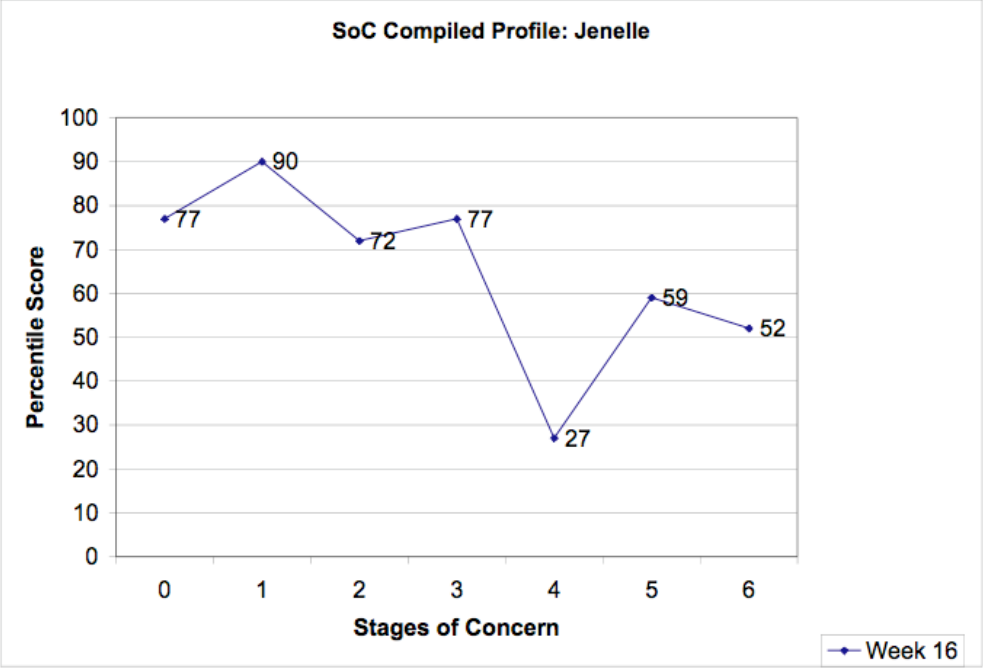


Figure 4.21: Jenelle's post lesson study concerns profile

Jenelle now has a single-peak informational concerns profile with additional peaks intensity indicating management and collaboration concerns. The major warning signs are gone, and she has a profile that is indicative of intense personal concerns about teaching inquiry lessons in science, and the consequences for herself. According to the peak intensities, the resistance to teaching in a new way is gone, and a reduction in Stage

0 indicates that she is beginning to become involved in some way in teaching inquiry. In her reflection after her teaching episode, she noted several things that did go well, and her group pointed out others. All agree that there are things to work on, and goals to work toward, yet, experiencing some of her students beginning to understand and make sense of the different characteristics of rock from her lesson was an invaluable experience, one which might have caused her to begin to re-evaluate her traditional framework for teaching.

Her final concerns (Table 4.16) begin to triangulate her concerns profile, along with her reflections, and final interview. They indicate that Jenelle no longer feels threatened by teaching an inquiry lesson, albeit she is very wary, and recognizes that she needs to learn much more about teaching inquiry lessons, and vastly improve her science content knowledge.

Table 4.16: Jenelle's open-ended statements of concern

Date	SoCq	Open-ended statements of concern
5/2/2006	1	Of course, it's terrifying to think of another lesson in which students prior knowledge isn't as fresh. But as I have learned, I can always prepare more activities to do to remind them, but yeah, it is nerve-wrecking when everything in the lesson kind of has to flow from one to the other [without] stop[ping], but when students don't know then it makes me nervous.
	3	It is sooo!!! hard to find the right materials or find material to match the lessons to prepare a constructivist lesson. I'm afraid students will have to do with pictures and readings from books.
	2	Another concern is the fact that I realized that I don't even know about the topics I needed to teach. I know I can say "I don't know" to the students and get back to them, but yeah… it's scarry. I don't want to end up being the teacher that doesn't know anything.

Discussion

For Jenelle, a metaphor of Crisis of Practice is appropriate, as during the lesson Jenelle seemed to have her image of teaching, and her image of science lessons severely

tested, as seen by her response (above) to the prompt "What did you think went well?" From her own words, she seems to recognize that she has a new look at teaching, and begins to understand that there are aspects of teaching that are new to her, things for her to work on. As we explore how Jenelle came to understand that her current framework was inadequate, our three lenses help provide perspective.

EPISTEMOLOGICAL LENS

To gain a perspective on how Jenelle views her own knowledge, how she perceives the nature of inquiry lessons in science, we have been using an epistemological lens. Providing data and interpretations for the basis of this lens are Green's (Green, 1971) metaphor for belief structures, Posner et al's (Posner et al., 1982) four criteria for conceptual change, Perry's (Perry, 1999) forms of intellectual and ethical development in the college years, and Belenky et al's (Belenky et al., 1986) categories of Women's Ways of Knowing. A synthesis of the data provides an avenue for inference of Jenelle's epistemological framework, and subsequent belief structure.

For Jenelle, her experiences have been in traditional classrooms, with repeated reinforcement of her traditional teaching beliefs throughout her K-12 schooling. Her image of teaching is traditional, as well as her beliefs about teaching. Table 4.17 is Jenelle's belief profile which indicates that, overall, her beliefs do not change.

Table 4.17: Jenelle's beliefs about teaching	Jenelle's beliefs about learning
1. How do you maximize student learning? 2. How do you describe your role as a teacher? 4. In a public school setting, how do you decide what to teach and what not to teach? 5. How do you decide when to move on to a new topic in your classroom?	3. How do you know when your students understand? 6. How do your students learn science best? 7. How do you know when learning is occurring in your classroom?

Teacher-centered------Student Centered

	Trad.	Instr.	Trans.	Early Const.	Exper. Constr.
Interview 1[as]	4 5	1		2	
Interview 2[as]	4 5	1	2		
Interview 3	4 5	1 2			

x' strongest response
x" second strongest response
x'" weakest response

Teacher-centered------Student Centered

	Trad.	Instr.	Trans.	Early Const.	Exper. Constr.
Interview 1[as]		3 6	7		
Interview 2[as]			3 6	7	
Interview 3		3 6	7		

* Secondary coder
[as] asynchronous interview

Table 4.17: Jenelle's TBI profile

When, however, we view her belief statements in light of an epistemological lens, we see that Jenelle's epistemological beliefs do change. In fact, after a crisis of practice, Jenelle has more evidence that is more likely to cause her to re-assess her beliefs in light of evidence, evidence that is either observed by her, or brought to her attention by her Lesson Study group. Earlier, there is not much data to indicate that she holds her beliefs on an evidentially held basis, as she listens to her inner voice exclusively. Thus, Jenelle's interviews, reflections, and behavior are consistent with Belenky et al's category of Subjective Knowledge, where the inner voice has been developed, and is the primary source of authority—to the exclusion of other voices. In fact, at the end of the semester, even though Jenelle has learned from her Crisis of Practice and begins to listen to other voices, or at least see them as important in the process of learning to teach, there is not enough evidence to indicate that Jenelle has changed categories. Yet, something has

changed. Jenelle is moving toward a perspective of shared authority (Belenky et al., 1986).

Before her Crisis of Practice, Jenelle did not appear to be dissatisfied with her existing framework that she used to make sense of new information from her classroom experience and university coursework. She viewed new experiences through a lens that she developed when she was a student, which is still being reinforced throughout her experiences at the university. Yet, when challenged to begin assimilating new experiences into her framework, and changing her framework to be consistent with a teacher's perspective, Jenelle did not appear to find new information intelligible. Using Posner et al's criteria, Jenelle's dissatisfaction seemed to be forced by her experience of learning to teach in a new way. She was forced to teach an inquiry lesson, and try to understand it with her traditional teaching framework. Evidence of her growing dissatisfaction was obvious in her nervousness, her concern statements and profiles, as well as in her enactment of an inquiry lesson. The fact that she did not find the new information intelligible was evident in her discussions, planning sessions, and use of materials to prepare her lesson. Hence, if the information is not intelligible, it will hardly be plausible, or fruitful (Pintrich et al., 1993).

After Jenelle's Crisis of Practice, she has a new look at information from her university course, and begins the process of adaptation with a new outlook. There are weak indications that she is beginning to find the information intelligible; however, much remains to be seen.

Using Green's metaphor, Jenelle's beliefs were non-evidentially held, as she used her existing beliefs and framework to explain or interpret situations and not evidence gathered during the course of planning and teaching. At the center of her belief structure were primary beliefs grounded in her conceptions of teaching, formed during her culture

of apprenticeship (Lortie, 1975). She used these as the basis of her derivative beliefs, and to make sense of student learning, and to understand student understanding. Because she held so firmly to these beliefs, an assumption that can be made is that they were also psychologically centrally located as they were held with a high degree of psychological strength. Evidence of the psychological strength with which she held to her traditional teaching beliefs (her traditional framework for teaching) may be seen in the developing Crisis of Practice. By the end of the semester, Jenelle recognizes that her traditional framework needs to change, but it took a crisis to force this recognition.

Expectational Lens

Insights into Jenelle's expectations for teaching and student learning can be derived from her interviews, and reflections. To her, school "works" for students in that they are expected to use the buzzwords, and teachers accept the use of buzzwords at face value. Evidence may be seen in the above excerpts in which Jenelle uses many key terms from her university course, with little to no explanation or evidence of understanding. Further, she often asks her interviewer, "like, you know?" and uses "you know?" often in one answer. When she does not receive a head nod or affirmation from her instructor and interviewer, she continues inserting buzzwords, and stringing her answer along.

> [00:00:13.07] Jenelle: OH. From like, at the beginning, I thought like the teacher was supposed to do everything, like, you just walk in there, you should have your lesson plan, and direct teach everything. But, now [laughs] I could totally not see myself direct teaching at any point. I just know how tedious it is. How students tend to like, "Oh what ever, you know" they assume, I mean, you know, like, what am I trying to say? Like, they get, not lost, but [pause] Oh God, it's been a long day. Uhm. What is it called? Like, they lose attention? How do you say that again?
>
> [00:00:42.00] Instructor: Oh, lose students attention?
>
> [00:00:46.10] Jenelle: Yeah. You know, because it's like, whatever. But now, like, I really like the whole entire like constructivist, or like the inquiry teaching type

of lessons. I just love the fact that you can add so much more like, you know, like hands-on activities. Even though it's kind of hard to actually find material, or material that actually fits your lesson. It's still so much more rewarding when they-students actually get to see and you don't really have to explain much, you just have to give them a background knowledge or like the overarching like theme of it, and then they pretty much do like everything on their own. And, it's pretty nice how to see how like, they kind of wrap up your own lesson. And-

[00:01:23.08] Instructor: How do they wrap up your lesson?

[00:01:25.11] Jenelle: Yeah like, you don't necessarily have to like say everything that you intended to, like, do with them. Because the students will be like, when they're discussing, and when they are presenting to you what ever they did during the lesson, they pretty much you know, that's their way to tell you, you know, that they learned "this, this, and this." And then, if there's anything to do for teachers, probably like give them, like specific vocabulary, and I think I've mentioned this a whole bunch of times. But like, during the explain section, I always do like a small direct teach. Because I just think it's important to like, give them specific vocabulary and stuff like that. But, other than that [laughs] I don't want to teach like, give them all the information anymore. Then, yeah.

Jenelle's inner voice is still evident in her discussion about teaching what is not allowed.

[00:06:49.10] Jenelle: The thing, the thing is like, of course I'm not going to go out and "yall, today we're going to talk about sex or religion or anything" I'm probably going to like get the parents, like, permission, and, pass it by the school, and kind of modify it or, you know, make it more, like, [unintelligble], I don't know. I'm just going to like, present the material that you know, they can understand and it's at like, their maturity level. I'm not going to give them or provide them with stuff that they, would not understand. There's really no point to it.

[00:07:20.00] Instructor: I think that was "grade appropriate." Was that the word you were looking for?

[00:07:21.27] Jenelle: Yes.

[00:07:22.27] Instructor: Yes.

[00:07:26.08] Instructor: Uhm, how would you decide what, uhm, I mean, do you have an example of what would be controversial that you might teach?

> [00:07:33.08] Jenelle: I think religion, mostly [laughs] but I'm very, very religious. And I think, here and there I'm going to slip one of my Christian messages, or Christian whatever. And, I know I pick like the most, like I LOVE Hispanic populations and all my schools have been like, working [unintelligible word] Texas. And I know most of them are Catholic. So, there's really not much difference, but like, the things that, I'm not going to like, try to convert them or anything, but I guess just like the fact that there is a greater power there. Or whatever. And, I'm not trying to like make problems with their parents or, anything. But, if for example I wanted to teach them about different religions, and stuff like that, [pause] I would go ahead and do it just as long as like I'm not saying that "Oh you should be Christian because this is good, and this is bad, and this thing is bad." So it's just like giving them like, information [stressed] of like, or description or whatever."

In sum, Jenelle has an well-developed, traditional framework for teaching with centrally located beliefs held with a high degree of psychological strength. Jenelle's statement "here and there I'm going to slip one of my Christian messages…(00:07:33:08)" is very different than any of Rebecca's statements during her interviews. Recall that Rebecca does not listen to her inner voice, and is not able to reconcile the contradiction that she perceives between the canonical text and teaching of science content. Rebecca doesn't attempt to "slip" in a message, indeed, she is not able to navigate the tension that exists, whereas Jenelle recognizes a tension, yet intends to interject "Christian messages" into her lessons. Rebecca, unlike Jenelle, side-steps this tension with "I guess you have to go with what the rules say" (Reb_4_15).

SOCIAL/AFFECT LENS

Aside from Jenelle's overt uneasiness and nervousness, the Social/Affect lens provided the earliest indicators that a crisis was looming, as has been discussed above. In Jenelle's case, the Stages of Concern instrument and literature provided guidance for the instructor, as well as information that helped guide instruction, or in Jenelle's case, reflection. This, combined with additional perspectives might very well have been an avenue to avoid Jenelle's Crisis of Practice.

Chapter 5: Discussion and Implications

The two research questions that have been guiding this study are: 1) *Do pre-service teacher belief structures change during the implementation of a Japanese Lesson Study cycle? If so, how and to what degree do they change?* 2) *To what extent are preservice teachers teaching behaviors consistent with their belief structures?* The purpose of this study is to investigate existing beliefs and images of teaching held by preservice teachers, through the use of the Japanese Lesson Study protocol.

For question one, there are two answers. First, regarding preservice teacher beliefs, on the surface, neither Rebecca, Lea, nor Jenelle's beliefs change. They are all described by the TBI as non-changing. On a deeper level, their belief structures provide different indications. Rebecca's belief structure does not indicate perceptible change. Indeed, she seems to pull back into a holding pattern and defer to a source of authority that does not include her inner voice. Lea's belief structure seems to undergo the most significant changes, as she seemingly systematically reflects on her beliefs, ultimately coming to understand her foundational and primary belief about the role of the teacher. Jenelle's belief structure, by the end of the semester, indicates that she may be beginning the process of a major restructuring of her beliefs. The major indicator was her Crisis of Practice that created a force that seemed to necessitate listening to other voices, mainly her Lesson Study colleagues. To further illustrate these ideas, three metaphors seem appropriate: Rebecca-Crisis of Belief; Lea-Quiet Examination; and Jenelle-Crisis of Practice.

CROSS-CASE COMPARISON

Three metaphors

Three metaphors were used to describe changes that occurred, one immediately obvious, one not so obvious, and one hidden. Jenelle's Crisis of Practice was immediately obvious in her Stages of Concern inventory, whereas Rebecca's Crisis of Belief was not so obvious. Both shared several surface characteristics, yet, the trajectories of their Crises were different. Only Lea, described by the metaphor Quiet Introspection, seems to fit students who are characterized by teachers as "a good student." Why is this? Does this mean that Rebeca and Jenelle are "bad" students? Not in the least. If anything, teacher educators who label students might benefit from these three cases. This cross-case comparison will be structured by the three lenses that have been used, above, which address the first research question: *Do pre-service teacher belief structures change during the implementation of a Japanese Lesson Study cycle? If so, how and to what degree do they change?*

First, from an epistemological standpoint, our three participants view their own knowledge about teaching science at the elementary level very differently. When planning collaboratively in groups, and reflecting on, and revising their lessons with the Lesson Study protocol the conversations may use the same terminology, yet, the meanings and interpretations are very different. For example, Jenelle and Lea both have developed their inner voice yet ascribe different priorities to their inner voice. Jenelle, a subjective knower (Belenky et al., 1986), listens exclusively to her inner voice while she engages in planning, and revising lessons. She uses the same words as her partners, Fausto and Carrie, yet, they do not construct an understanding of inquiry lessons that is consistent amongst their group. Lea, on the other hand begins the semester consistent with Belenky et al's category of Procedural Knowledge (connection version). She uses a

reasoned examination of new knowledge and experiences, which occurs during her conversations with her group members (Rebecca and Claudia), and individually as well.

Rebecca, begins the semester exhibiting characteristics (at times) consistent with Belenky et al's categories of Silenced, or Received Knowledge. She has not developed an inner voice that is readily apparent, and often picks on her understanding of teaching and practice critically, almost, it seems as if she is used to hearing criticism leveled at her. Both Rebecca and Jenelle self-characterize themselves as "very religious" yet only Rebecca uses religion as a way to make sense of science—a framework of sorts. Rebecca ascribes her orientation toward knowing based on the canonical text as the religious authority, with no place for her to interpret the text, or even teach something that is not explicitly written in the text. This is consistent with Belenky's categories of a Received Knowler, and at times, Silenced. Jenelle, with the discovery of her inner voice, recognizes that she is very religious, yet, negotiated the authority of the canonical text to add to her authority.

Orientation toward knowing on the basis of authority, and evidentially held beliefs

As presented, in Rebecca's case, her judgments were made on a non-evidential basis in which she does not listen to her inner voice, only to her ascribed authority. This corresponds to (at the very least) the Perry stage of Dualism or Multiplism (Perry, 1999). Belenky et al describe as representative of the category of a received knower in that Rebecca does not "hear" her own voice as contributing to a conversation or evaluation of knowledge in light of evidence. Thus, when concerned with evidence generated from within authentic contexts, Rebecca seems to defer to the Canonical text as the authority. To Rebecca, her evidence derived from her orientation toward knowing based on an authority, which was the text of the bible—it is either there in the text, or it is not. To Rebecca, her primary beliefs were, themselves, derived from a source of authority, which

Rebecca could not dispute, or interpret. Thus, Rebecca was dissatisfied with her existing conception of teaching science; yet, she did not find the new conception of teaching science intelligible, based upon her adherence to an external authority's expertise. Because she did not find the new pedagogy intelligible, she would not find it plausible, nor fruitful.

For Lea, judgments were evidentially based, she does hear her inner voice, and value her own evaluation of evidence that she gathered in authentic contexts, or through reflection. This evaluation corresponds to Belenky et al's category of Constructed Knowledge, in which Lea evaluates knowledge on the basis of evidence (knowledge is evidentially held) and integrates her voice with that of those she ascribes to authorities. In short, she sees herself as an authority, who is learning to teach science at the elementary level. For Perry, Lea seems to fit into an early stage Commitment in Relativism, possibly Initial Commitment at the beginning of the semester and Orientation in Implications of Commitment by the end of the semester.

Initially, Jenelle did not view new knowledge and interpret new situations on the basis of evidence. Indeed, the initial beliefs that she held about teaching and student learning in science were held on a non-evidential basis. It took a Crisis of Practice to have her recognize that she needed to begin examining her prior traditional beliefs on the basis of evidence produced through her coursework, and experiences in authentic contexts.

Green's Metaphor (Changes in Belief Structure)

At the end of the semester, only Lea had a noticeable change to her belief structure. She came to recognize that her primary belief about teaching was a traditional belief. Overall, her belief profile exhibited no change as compared to the beginning and end of the semester, yet, an interview right before she enacted her planned lesson did

exhibit changes with respect to her beliefs about learning. This indicates that Lea was working to make sense of new information, yet, after her first experience in teaching a science inquiry lesson, reverted back to her initial beliefs. She offers advice to future instructors to add a second, required, inquiry lesson every semester, recognizing the logistics problems that a second lesson would entail.

Rebecca and Jenelle, when comparing beginning and end belief profiles, exhibit no change, yet, something happens to their beliefs as they collaboratively plan for their lessons. Perhaps they, too, would benefit from a second Lesson Study cycle.

The second research question: *To what extent are preservice teachers teaching behaviors consistent with their belief structures?* is best answered by looking at the differing perspectives and reflections on each individual's implementation of an inquiry lesson. In most instances, the instructor's perception was quite different from the preservice teacher's perceptions of the lessons they enacted. The reader will recall that all lessons were collaboratively planned with each group and the instructor. The assignment was to plan and enact an inquiry lesson in an elementary classroom, which required several iterations between student groups and the instructor.

Boxplots were constructed with standard error bars. Most error bars did not overlap, indicating that perceptions of the instructor and students were different. In most cases, student perceptions were similar to each other, and the instructor's vastly different. Specifically, preservice teachers tended to rate themselves and their peers high, indicating that they perceived that the lesson, as enacted, was an inquiry lesson. The instructor rated all enacted student lessons as good first attempts as enacting inquiry in authentic contexts. Preservice teacher perceptions were that their elementary students had much opportunity to explain and justify their ideas, as well as share the control of design and management of learning activities, and social norms of the classroom. Indeed, the

classrooms in which these lessons were enacted were only their intern classrooms, not apprentice classrooms. In this sense, most interns did not have much say with the rules of the classroom, or lessons that preceded or followed their lesson.

FRAME OF REFERENCE

The significant difference in ratings indicates that preservice teachers are beginning to understand how inquiry lessons are enacted; however, as the preceding sections in chapter 4 indicate, there is more to the individual perception.

If the point of preservice teacher education is to produce highly qualified teachers for modern classrooms, then we must create opportunities in which preservice teachers identify their past experiences in science classrooms, and strive to recognize how their experiences impacted, indeed, shaped the formation of their current beliefs and images of teaching science. Mary Kennedy calls this a "frame of reference" (1999, p. 55).

Kennedy grounds her argument in Lortie's apprenticeship of observation (Lortie, 1975, p. 61). Preservice teacher experiences in their own K-12 educational experiences have developed, through observation and participation, an expectation of how teachers and students perform and are supposed to act in classrooms (Kennedy, 1999, p. 55). These experiences have formed a set of expectations, though which, beginning teachers view appropriate teaching practices, and interpret directives and high-stakes testing environmental pressures.

TWO PERSPECTIVES

If we agree with the above point of preservice teacher education, two helpful perspectives will provide fertile ground upon which to help preservice teachers "reframe" their frame of reference. Both are different perspectives that can be used in a teacher education program. The metaphor perspective may be used *with* preservice teachers to

better understand their practice during their first semester. The CBAM perspective may be used by teacher educators to restructure their curriculum in order to plan *for* instruction, and provide opportunity for preservice teachers to better understand their existing beliefs and images about teaching and student learning, and make sense of new information.

The first perspective, the metaphor perspective, suggests that teacher educators identify metaphors that represent each preservice teacher's practice during their first semester. During subsequent semesters, teacher educators may then have each preservice teacher compare their personal metaphor with the metaphor suggested by the teacher educator. Suggesting these metaphors to preservice teachers in their second semester, and having preservice teachers respond to their individual metaphor, in a longitudinal sense, may help preservice teachers reframe their teaching practice, and develop into classroom teachers who have classroom practice consistent with their belief structures.

A second perspective, the CBAM perspective, is a perspective that will help guide curriculum decisions for teacher educators. The CBAM perspective is grounded in the four assumptions of the CBAM, which will help synthesize the above three cases, and help us understand the contribution of the epistemological, expectational, and social/affect lenses. Indeed, the following assumptions of the CBAM may help us to re-evaluate change in education to be a "**trajectory** of change."

CHANGE IS A HIGHLY PERSONAL EXPERIENCE

As presented, three preservice teachers have very different experiences, yet, they have to work together to negotiate meaning within their existing framework, and have conversations guided by their existing frameworks. Thus, in this sense, change must be a highly personal experience. Without knowledge of existing preservice teacher frames of

reference, there is no understandable learning trajectory to help students better interpret new ways of teaching.

As an example of differing frames of reference, both Lea and Rebecca were in the same Lesson Study group. Epistemologically, they were in very different places. Fundamentally, Rebecca and Lea viewed their own knowledge differently, based upon their orientation toward knowing based on authority (Perry, 1999). Rebecca ascribed knowledge to a canonical authority, and looked to the text to guide what she learned. Absent guidance, she decided to teach what the curriculum told her to teach. Thus, this forced her trajectory of learning to teach toward younger grades, mainly Kindergarten, in order to minimize the occurrences in which she perceived that she would be lying to students—teaching something that was not in the canonical text.

Lea ascribed her orientation toward knowing as grounded within an expectation of shared authority. She shared authority between her internal voice and external voices, such as her classroom teacher, Lesson Study colleagues, and university instructor. Her beliefs were beginning to be re-evaluated in light of new evidence; yet, she still holds a traditional teaching frame of reference. Jenelle too, has a traditional frame of reference, yet, is different from her Lesson Study colleague, Lea in that they see the use of evidence differently.

While Rebecca, Lea, and Jenelle hold traditional frames of reference, fundamentally, they are different. Seeking to understand the differences between the three belief structures leads to an understanding that, on the surface, the beliefs looked similar, yet the structure is completely different. Indeed, the three hold different beliefs with varying degrees of strength. In addition to similar beliefs about the role of the teacher, they all held beliefs about student learning that were separate from the beliefs

about teaching. In this sense, the beliefs about student learning are clustered (isolated from)_beliefs about teaching.

CHANGE IS ACCOMPLISHED BY INDIVIDUALS

Indeed, as Lea and Jenelle have shown, a trajectory of change is accomplished by individuals. The university instructor alone could not accomplish change, and create understanding of inquiry lessons. He could only create opportunities in which preservice teachers might reevaluate their existing beliefs, like Lea, about teaching, and begin a trajectory of change across their future years of teaching. For Jenelle, emerging evidence points to a shift from non-evidentially held beliefs to potentially evaluating her beliefs on the basis of evidence.

CHANGE IS A PROCESS, NOT AN EVENT

Expecting all preservice teachers to be able to make sense of inquiry in science classrooms, and have that understanding be directly translated into practice after 15 weeks is, from Bryan and Abell (p. 136) a fallacy of assumptions. However, as Luft and Roherig discussed, the teacher education program does make a difference in how practicing teachers make sense of contemporary teaching practice. Therefore, induction programs must continue the trajectory of change that starts with preservice teacher education.

CHANGE IS BEST UNDERSTOOD IN OPERATIONAL TERMS

For preservice teachers, learning new ways of teaching that are potentially very different from their existing beliefs about teaching may be threatening. Having them describe, evaluate, and prescribe action is one way to operationalize and structure their sense-making of new information and experiences, as well as guide their reflection on differences in expectations inherent in different frameworks.

IMPLICATIONS

As Mary Kennedy discusses, "one reason teachers are able to learn to teach almost exclusively through their own teaching experiences is that they know what is supposed to happen. Their frame of reference enables them to judge their daily successes against a standard of expectations" (Kennedy, 1999, p. 55). With instruction of methods that do not fit preservice teachers expectations, like Rebecca, Lea, and Jenelle, instruction needs to begin by recognizing their existing frame of reference, and challenge preservice teachers to explicitly interpret new experiences and new information from their existing frame of reference, and to construct a new frame of reference. In this sense, there is an added depth to the expectation of teacher educators: to understand preservice teacher understanding of teaching.

With this increased depth, comes added work. What this means is that teacher educators must seek to make explicit each individual preservice teacher's current frame of reference—including their images, episodic memories, expectations, and epistemologies. Teacher educators, then, need to help guide and facilitate preservice teacher sense-making as they begin the process of assimilating new information with their existing frame of reference. Indeed, as preservice teachers strive to understand contemporary teaching pedagogies in science, teacher educators provide several things.

Firstly, as teacher educators seek to teach new frame of reference, they must seek to provide appropriate (new) apprenticeship of observation experiences. By cultivating new internship classrooms in which the cooperating teacher also seeks to understand new methods of teaching from preservice teachers, or seek cooperating teachers who seek to help preservice teachers negotiate high-stakes testing pressures with contemporary methods of teaching science, new apprenticeships of observation may be achieved.

Secondly, teacher educators must seek to operationalize this new frame of reference from the preservice teacher's point of view. What this entails is to have preservice teachers operationalize new experiences and information by describing, evaluating, and prescribing future actions in specific contexts. By describing lessons in different contexts, evaluating actions and intentions from traditional and contemporary perspectives, and advocating actions in specific contexts, preservice teachers will have much to guide their reflections as they begin teaching in authentic contexts.

Lastly, as preservice teachers reflect on their teaching behaviors and choices made as they enacted their inquiry lessons, they can interpret their actions with respect to their intentions, and further challenge their existing frame of reference and expectations of teaching. For Jenelle, this seemed to be a crucial step. Whether she re-evaluated her existing frame of reference causing a reorganization of her beliefs is not in the data.

For Green (1971), the activities of teaching are four-fold. First, teaching seeks to minimize the number of core beliefs in a belief system, like Lea appeared to do when her initial beliefs about teaching narrowed to a single, traditional belief about the role of the teacher. Second, teaching seeks to minimize clusters with maximum number of relations. By seeking to help preservice teachers increase the maximum number of relations between their core beliefs, and minimize clusters, teacher educators are challenged to help each preservice teacher make sense of, and understand new information in light of their existing frame of reference. For Rebeca, Lea, and Jenelle, their beliefs about how students learn and come to an understanding in science classrooms is different from, indeed, clustered and protected from their traditional beliefs about teaching. Teacher educators must facilitate preservice teacher exploration of their beliefs about teaching, and about student learning in science by creating experiences that force disequilibrium between these clustered beliefs. Ultimately, helping preservice teachers have an

understanding of multiple perspectives, and how their beliefs fit into existing classroom situations may help them as they enter into the profession.

Third, teaching seeks to maximize the proportion of evidentially held beliefs, whether about the role of the teacher, or assessment of student learning in classrooms, making informed decisions about classroom practice and assessment is an important characteristic. Lea entered into the program with an epistemology that valued evidence from new experiences. Jenelle seemed to recognize the use for evidence generated from personal experiences, and Rebecca's epistemology utilized evidence from another source. Rebecca did not know what to do, or how to negotiate the disequilibrium between her ascribed authority to canonical text, and her developing authority in classrooms. She might have benefited from specific guidance early in the semester, or benefit from a least set trajectory for exploration and elucidation of her existing frame of reference—her beliefs about teaching and student learning with respect to her understanding of authority in science classrooms.

Green's last characteristic, creating belief structures that maximize correspondence between quasi-logical order and actual logical relations is difficult. This requires a shared authority, or at the very least a recognition of different types of authority in education, and differing perspectives coming to bear on education. This can only be developed through experience, and guidance in learning. Otherwise, as Green notes, indoctrination occurs (p. 55).

In sum, Kennedy's discussion of the role of preservice teacher education is especially important. Reshaping preservice teachers' frame of reference "enables them to judge their daily successes against a standard of expectations" (p. 55). Indeed, preservice teacher education occurs at a juncture in time, which is located between preservice teacher's past experiences, and their future experiences (p. 57). Teacher educators need to

create experiences that specifically create a new standard of expectations, against which, current preservice teachers use to guide their future practice.

Returning to the point of this research, understanding how preservice teachers think and make sense of new information with respect to their existing beliefs and frame of reference is important in preservice teacher education. The use of three lenses, and existing measures helps to understand preservice teacher epistemologies, expectations, and affect. Indeed, these three lenses suggest a pathway in which teacher educators may take to create experiences that offer opportunities for preservice teachers to reevaluate their existing beliefs as they create a contemporary frame of reference. Rebecca, as her Crisis of Belief indicates, a Social/Affect, or an epistemological pathway for learning may be helpful. She recognizes that she has an expectation for completing assignments in education. Jenelle, as her crisis of practice indicates, has had to confront her own experiences and expectations before collaboration "means anything." She may be helped by the use of a Social/Affect lens, as she explores the use of appropriate terminology with colleagues, and negotiates understanding from her colleagues' perspectives. Lea, with her quiet introspection, clues us in to the creation of experiences within collaborative groups—already valuing the use of evidence in reflection upon her existing beliefs, may be further challenged by a deeper understanding of student understanding (Duckworth, 1996). The added challenge to further her understanding of inquiry lessons may help to address the clustered beliefs about student learning within her own belief structure.

The lesson study protocol seems to provide structure and support for both Lea and Jenelle, yet for Rebecca, not connecting with her coursework and colleagues seemingly because of irreconcilable aspects between belief structures, the structure provided by lesson study (and her university instructor) do not seem to be able to provide the necessary support to help make sense of new information. All remained open and caring,

yet, Rebecca seemed to have difficulty making connections between her existing beliefs, and new information.

Is 15 weeks enough time to begin a trajectory of change in our three participants? The short answer, "no;" however, as teacher educators seek to better prepare preservice teachers to enter into the highly-charged atmosphere of contemporary classrooms, some changes are evident. Implications for 15 week, single, Elementary Science Methods course include sections, which enable preservice teachers to take charge of their learning. The trajectory includes, seeking to expose existing and create images of teaching by re-framing traditional frames of reference. This consists of explicit instruction about the role of teacher (image, expectations, and dialog of evidence), and the role of the student (image, expectations, and dialog of evidence). The trajectory includes help in understanding a "new frame of reference" with respect to past experiences, and the implications for guidance. This may be done with the creation of "threads" across teacher education programs in which a contemporary frame of reference for teaching is expanded across a variety of domains, in authentic contexts, with the expectation that preservice teachers begin to take charge of their learning trajectory, as Lea did.

FUTURE RESEARCH

If the implication for practice for teacher educators is to use one of the three lenses as a pathway to help students reflect upon their existing beliefs, then much research needs to be done to begin to more fully expand on the use of these three lenses within practice. Do the indicators exhibited by Rebecca, Lea, and Jenelle pertain to other preservce teachers? Future research that needs to be completed is to finish the collective case study, while more fully understanding what is entailed by the three phenomena: Crisis of Belief, Crisis of Practice, or a Quiet Examination of existing beliefs. Indeed, the indications of the two crises need to be better understood with respect to the theoretical

framework proposed by this study. In order to make a large step in this direction, completing the other 22 cases will expand and deepen our three phenomena as the cases are constructed. To be sure, this study was conducted in an elementary science methods course. This leaves many aspects to be researched. For example, questions such as: To what degree do secondary education preservice teachers exhibit such characteristics of belief structure, and how do the preservice teachers make sense of new information in light of their existing belief structures? Future research needs to be done to better understand how preservice teachers, at any level, make sense of new information with respect to their existing beliefs, belief structure, and images of teaching. This framework creates an interesting pathway in order to structure a longitudinal study of preservice teacher beliefs across domains, teaching certifications, and level.

LIMITATIONS

Research on belief change is increasing in frequency; yet, there is still much research that does not explicitly state the operational definition of belief. This research explicitly pulled from literature that used one single definition of belief (Rokeach, 1968) to the exclusion of much research on beliefs that do not explicitly state the operational definition. There is much work to be done with the framework presented in this work to explore various definitions belief, and synthesize the findings from each. Then, a more coherent literature base may take shape across disciplines.

A second limitation is found with the researcher. The experiences and beliefs of the researcher may influence, or misunderstand the beliefs, and subsequent belief structure of each of the participants. Indeed, the researcher is monolingual, male, specializes in chemistry with many years of secondary teaching experience, whereas the three participants are bilingual and female, with no formal teaching experience, and little science background.

Third, since this research is a case study, it is not generalizable. Three participants were selected from a collective case study, with an additional 22 more to be completed.

Fourth, with the use of existing methods in different ways, as well as the creation of a new framework based on two exploratory studies and a single definition of belief, more research needs to be done to fully explore the use of the framework across definitions, domains, and certification levels.

Last, the success of Lesson Study is not readily apparent in a short term, one semester course. Further research is needed to fully realize the capabilities of a protocol that changed the educational community of the school environment in Japan.

Appendices

APPENDIX A: PERMISSION TO USE STAGES OF CONCERN INSTRUMENT

SOUTHWEST EDUCATIONAL DEVELOPMENT LABORATORY
Building Knowledge to Support Learning

211 East Seventh Street Austin, Texas 78701 Voice: 512/476-6861 Fax:512/476-2286

TO: Brian Fortney (Licensee)

FROM: Joyce S. Pollard, Ed.D.
Director, Office of Institutional Communications

SUBJECT: Permission to reprint and distribute SEDL materials

DATE: January 19, 2006

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Sincerely,

_____
For Southwest Educational Laboratory

Agreed and accepted:

Signature:_____ Printed Name: _____

Date signed: January 19, 2006

Additional SEDL permission information

1. Give the complete name, title (if a person), and official address of that entity (person or institution) that has the legal right to request and be granted license for use.

Brian Fortney
Then University of Texas at Austin
1 University Station Mailcode: D-5500
Austin, TX. 78712
bfortney@mail.utexas.edu

2. Briefly describe the purpose and audience for which you are requesting permission to use SEDL materials.

I am requesting the use of the Stages of Concern questionnaire for use in my elementary science methods courses from Spring 2006 until the Spring of 2007. I will be doing research on the belief structures of pre-service teachers, and have structured my course to address student concerns as they learn to teach elementary science in a field-based course. This will be my dissertation study.

3. Describe the format (e.g., print, Web, digital image) for which you are requesting permission to publish or duplicate the SEDL work. Please be as specific as possible. Indicate whether you are asking for permission to reproduce, distribute or sell the SEDL work in a different format than the original format.

I am not looking to distribute or sell any of the SEDL work. I am requesting permission to use the Stages of Concern questionnaire in my dissertation study from the Spring semester of 2006 until the Spring semester of 2007.

4. If you are requesting use of SEDL materials in a publication, please indicate which one below:

_____ Article in scholarly or trade journal
____X__ Dissertation
_____ Monograph or chapter published by trade publisher
_____ Other (please describe)

5. Please give the estimated print run of the first publishing.

Dissertation completion: May 2007

6. State the time frame for which you are requesting permission
(e.g., for publication in Spring 2004, publication; or for a professional development session in June, 2004).

The time frame for use of the Stages of Concern questionnaire is for the duration of my dissertation study. This study will end in Spring 2007

7. If you plan to charge for the final product or presentation, please describe the cost structure and the price (e.g., cost recovery only, registration fee of $XX to include materials)

I do not have plans to charge for the final product or presentations.

APPENDIX B: INTER-RATER AGREEMENT

The following inter-rater agreement statistics reports are summaries of the inter-rater between Kurt Oehler and Brian Fortney. Both raters have extensive rating experience with the TBI. I wish to give special thanks to Kurt for his time and efforts.

Table B.1: Inter-rater agreement

(Rebecca)	TBI 1		TBI 2		TBI 3	
Question Number	Rater: K	Rater: B	Rater: K	Rater: B	Rater: K	Rater: B
1	2	2	2	2	1	2
2	1	1	1	1	1	1
3	2	2	1	1	2	2
4	1	1	1	1	1	2
5	2	2	2	2	2	2
6	1	3	1	1	3	3
7	2	2	2	2	x	X
Agreement	6/7	86%	7/7	100%	5/7	71%
Agreement with in category	6/7	86%	7/7	100%	6/7	86%
Overall Agreement	18/21	86%		Overall Agreement with in category	19/21	90%

(Lea)	TBI 1		TBI 2		TBI 3	
Question Number	Rater: K	Rater: B	Rater: K	Rater: B	Rater: K	Rater: B
1	1	1	2	2	1	1
2	1	1	3	3	1	1
3	2	2	2	2	2	2
4	2	2	3	3	1	1
5	2	2	4	4	2	2
6	2	2	2	2	1	1
7	3	3	2	2	3	3
Agreement	7/7	100%	7/7	100%	7/7	100%
Agreement with in category	7/7	100%	7/7	100%	7/7	100%
Overall Agreement	21/21	100%		Overall Agreement	21/21	100%

				with in category		

(Jenelle)	TBI 1		TBI 2		TBI 3	
Question Number	Rater: K	Rater: B	Rater: K	Rater: B	Rater: K	Rater: B
1	2	2	2	2	2	2
2	4	4	3	3	2	2
3	2	2	3	3	2	2
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	2	2	3	3	2	2
7	3	3	4	4	3	3
Agreement	7/7	100%	7/7	100%	7/7	100%
Agreement with in category	7/7	100%	7/7	100%	7/7	100%
Overall Agreement	21/21	100%		Overall Agreement with in category	21/21	100%

APPENDIX C: EXAMPLE OF PRESCRIPTIVE PROMPTS

An example question from the 4-8 Science Test Preparation Manual (Texas Educational Agency (TEA), 2006)

4. Which of the following strategies would be most effective to use in creating an environment that encourages the development of biliteracy and biculturalism?

   A. Incorporate materials related to students' home cultures and texts in students' primary language throughout the curriculum.

   B. Build opportunities for English language and literacy development into all areas of the core curriculum.

   C. Host food and clothing days featuring the home cultures of students in the class and encourage the students' parents to participate.

   D. Decorate the classroom with student drawings based on readings of stories from students' home cultures.

The item above measures competency 001:
The beginning bilingual education teacher understands the foundations of bilingual education and the concepts of bilingualism and biculturalism and applies this knowledge to create an effective learning environment for students in the bilingual education program.

34. Students in a second-grade bilingual class are beginning an interdisciplinary unit about plants. To help students monitor their own learning during the unit, it would be most effective for the teacher to:

A. provide them with a checklist of all the activities in the unit and encourage them to mark off each activity as it is completed.

B. encourage them to keep all of their unit work in a folder and keep a record of each grade or teacher comment on the inside cover.

C. help them develop a learning log in which they write what they know about plants and then verify their understandings throughout the unit.

D. teach them how to use reference materials about plants and then encourage them to correct their own errors on unit work.

The item above measures competency 004:
The beginning bilingual education teacher has comprehensive knowledge of content-area instruction in L1 and L2 and uses this knowledge to promote bilingual students' academic achievement across the curriculum.

4. **Use the information below to answer the question that follows.**

At the beginning of the year, students in a middle school science class are given the following form, outlining a problem analysis procedure.

Problem Analysis Form

1. What is the problem? _____
   _____
2. What are the causes of this problem? _____
   _____
3. What are the effects of this problem? _____
   _____
4. How could this problem be solved? _____
   _____

After students have become familiar with the problem analysis procedure, they work in small groups to use the procedure to explore information in several research papers on global warming. Each paper presents a different perspective on the problem, its causes, its effects, and possible solutions. Groups then share and discuss what they have discovered and are surprised to find that the papers present so many different perspectives. This activity is best for helping students recognize that:

A. science has few absolute answers to the world's problems.

B. making new scientific discoveries requires interaction among many different scientific disciplines.

C. new scientific theories must be tested before they are accepted.

D. scientists cannot draw conclusions about a phenomenon until they have observed it many times.

The item above measures competency 004:
The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

These question examples were then followed up with a written justification as to why the preservice teacher selected the answer that s/he did.

APPENDIX D: DESCRIPTION OF LESSON STUDY

In the structure of this research, the main pathway or framework to facilitate change in university student thinking about teaching and learning is called Lesson Study. A brief description of Lesson Study follows, however, to summarize what, exactly, university students do in lesson study: university student participants in this study participate in collaborative planning, individual classroom teaching in authentic classrooms, individual and group reflection components, and group discussion/re-planning, and justification of changes in plans. In the case of elementary science teacher education, this entails a component in which pre-service teachers teach in authentic classrooms, and are afforded the time to reflect, discuss, and make the connections that are paramount for learning to be a classroom teacher.

Lesson study – Background

Basically, lesson study consists of four phases:

1. Goal-Setting and Planning

2. Research Lesson (One planning team member teaches, while other team members observe and collect data)

3. Lesson Discussion (Share and analyze data and observations collected at the research lesson.)

4. Consolidation of Learning (Refining and re-teaching the lesson. Writing up and compiling evidence that was gathered and lessons learned.)

(C. C. Lewis, 2002, p. 3)

Lesson study is comprised of four phases, or steps for use in professional development. These phases have been adapted for pre-service teachers, from Catherine Lewis' text: Lesson Study: A Handbook of Teacher-Led Instructional Change (2002).

For clarification purposes, pre-service teachers will be called university students, the methods instructor will be called the outside expert, the classroom/mentor teacher will be still called the classroom teacher or mentor teacher, and students at the K-4 level will be called elementary students. Likewise, borrowing terminology from Marble's (2004) publication, the lesson study process will be called a lesson study "cycle", "…with each cycle of design and delivery... referred to as an "episode," while the overarching teaching plan common to all three episodes is referred to as the lesson. (S. Marble, T., 2004)"

The following phases are pictured in Figure 2.1: The Lesson Study Process for a 3-Member Team, and described below.

Phase 1: Goal-Setting and Planning

This phase is comprised of using background experiences of elementary students (as determined through observation) to guide the formation of goals, and ultimately, the development of the lesson plan, for each lesson. In this phase, university students formulate goals that specifically guide their lesson formation and teaching. Ultimately, it is these goals that will guide observations made in the Research Lesson Phase – Phase 2. These goals will also guide reflection and discussion (in the respective phases), and should not be confused with the goals of the lesson, or (elementary) student goals (which are inherent in the actual lesson itself).

Phase 2: Research Lesson

Specifically, this phase is the actual teaching of the lesson, and, as depicted in Figure 2.1, the first university student will teach the lesson, and the other two university students (and outside expert) will observe, and collect data that is specific to the goals of the university student teaching the lesson, as well as the goals for the lesson study cycle.

It is important to note that the goals of the lesson study cycle may be different for each group of university students, or may be general class goals for the cycle.

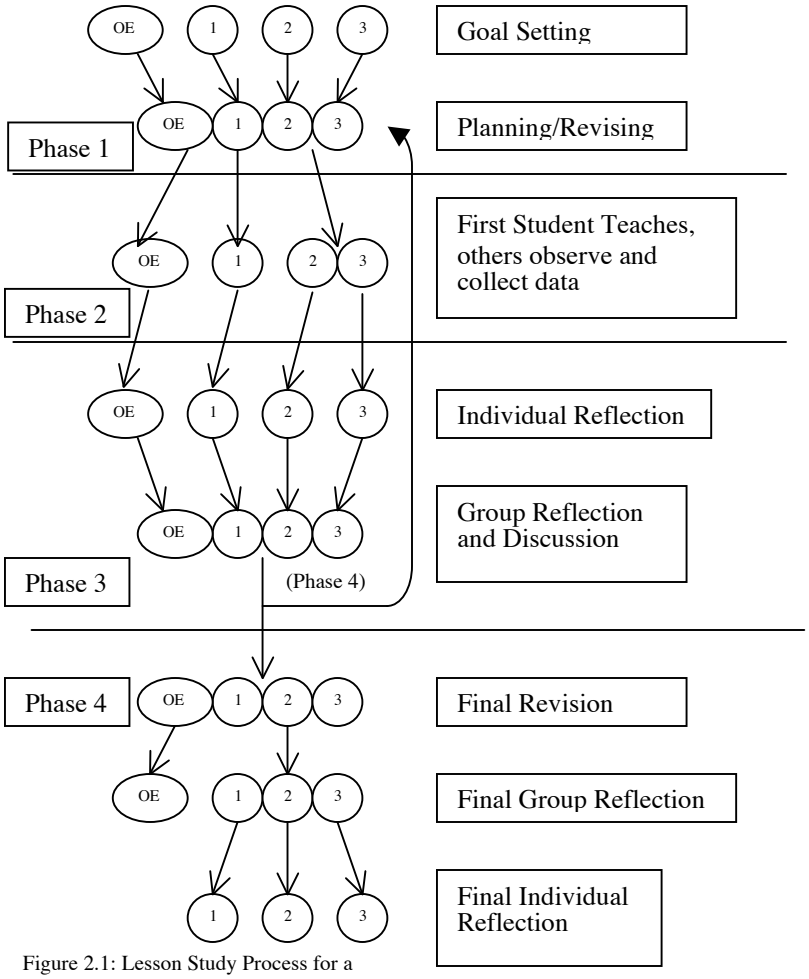

Figure 2.1: Lesson Study Process for a 3-Member Team
OE – Outside Expert
1, 2, 3 – Student group members

Figure D.1: Japanese Lesson Study diagram

To be more specific, the other two university students (and outside facilitator) collect data that is specifically guided by the goals of this episode and cycle. The observers record data that seek to describe actions of the teacher that did or did not

facilitate the predicted or intended student responses. It is this data that will play a key role in the reflection, discussion, and the revising of the lesson for the next episode.

After the data collection, it is important that everyone involved take time to compose their thoughts in a coherent manner that focuses on the goals of the lesson. What do the data say about information elicited (from elementary students) in response to the lesson planned?

Phase 3: Lesson Discussion

All involved in the episode will meet, and discuss their observations with the following order: First to talk and discuss: The person who taught the lesson (this helps to limit any defensive feelings), second: Other group members, third: Mentor teacher, principal, or other content expert, last: Outside expert. During this meeting, a group reflection will be synthesized, as well as revisions made to the lesson plan – in order to prepare for the next episode in the cycle. After this, the process begins again, at the observation and data collection stage, or proceeds to Phase 4.

Phase 4: Consolidation of Learning

After the last episode, reflections, and discussion, the final phase is a "synthesis of learning" that will be shared in some manner. It may be comprised of a written paper, or formative assessment that aims at sharing the experiences or learning from the cycle.

APPENDIX E: WEEK AND DATE CORRESPONDENCE

Table E.1: Week and date correspondence

Date	Week
1/17/2006	1
1/24/2006	2
1/31/2006	3
2/7/2006	4
2/14/2006	5
2/21/2006	6
2/28/2006	7
3/7/2006	8
3/14/2006	9
3/21/2006	10
3/28/2006	11
4/4/2006	12
4/11/2006	13
4/18/2006	14
4/25/2006	15
5/2/2006	16
5/9/2006	17
5/16/2006	18

APPENDIX F: EXPLANATION OF MULTPILE FRAMEWORKS

Table F.1: Multiple framework use

Exploratory Studies	Selection of Methods	Implementation	Interpretation of Data
Based on one definition of belief by Rokeach (1968), designed to: 1. Understand the nature of beliefs that preservice teachers bring to the course, and formulate a framework for the major study 2. Select, implement, and understand the use and interpretation of instruments that provide data for belief inferences, and inferences about belief structure	Based on the two exploratory studies, final instrument and procedure selections were made based on the framework developed through the two exploratory studies. Please see Tables 1.1, 2.1, 3.2, and 3.3.	Due to the nature of the study, a framework was needed to: 1. Structure the data collection in a baseline/pre/post design 2. Structure the implementation of the study in the context of a science methods course The Japanese Lesson Study protocol (Lewis, C. C., 2002) was selected to operationalize the work for preservice teacher instruction.	Once data was collected, the semester ended, and grades were submitted, data was integrated and interpreted. The multidimensional framework suggested by Tyson et al (1997) was selected for this purpose.

This appendix is intended to supplement the descriptions in this document, and provide an explanation of the framework used in formulating the two exploratory studies, which then guided the selection of methods for the main research study. With the implementation of the main study, a different framework was used to structure the data collection, and finally, with the integration and interpretation of data, a multidimensional framework was needed to guide the interpretation of data. This appendix is broken down into four sections.

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Vita

Brian Scott Fortney was born in Cincinnati, Ohio to James and Sally Fortney on August 26, 1968. He attended Maine Township High School South, Park Ridge, Illinois. In 1987 he entered The University of Iowa in Iowa City, Iowa and received his Bachelor of Science in Chemistry in May, 1992. During this time, he was heavily involved in undergraduate research in Inorganic Chemistry, and Astrophysics. He enrolled in a Master of Arts in Teaching program and received the degree in 1994 from The University of Iowa in Iowa City, Iowa. He student taught his last semester in conjunction with two programs. The first program was the Master's Degree program at The University of Iowa, Iowa City. The second program was a special urban teacher education program, The Cooperative Urban Teacher Education Program in Kansas City, Kansas. He graduated from both in August of 1994, and was co-author on his first published work in Astrophysics. During the following years he was employed as a Chemistry, Physics, Physical Science, and Environmental Chemistry teacher at Proviso Township High School West in Hillside, Illinois, Maine Township High School South, in Park Ridge, Illinois, Kohler Township High School, in Kohler, Wisconsin, and Brown Deer High School in Brown Deer, Wisconsin. In August of 2002 he entered the Graduate School at The University of Texas at Austin, and began teaching undergraduate courses while completing his doctoral work.

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